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Editor
Kristin L. Kraus

Cover Photo: Madison Hanny and Gene A. Ware, "Multispectral analysis of the Mangas Khipu Board," p. 81

Utah Academy of Sciences, Arts, and Letters

History: Founded 3 April 1908, the Utah Academy of Sciences was organized "to promote investigations and diffuse knowledge in all areas of science." Beginning in 1923, the Academy started publishing the papers presented in its annual meetings in *Proceedings*. In June 1933 at the annual meeting, the Academy was enlarged to include arts and letters, and the name was changed to the Utah Academy of Sciences, Arts, and Letters. Articles of incorporation and non-profit organization status were accepted by the Academy membership at the spring meeting in April 1959. In 1977, the name of the journal of the Academy was changed from *Proceedings* to *Encyclia*. It became a refereed journal at this time. In the mid 1980s, the scope of the Academy was expanded further to include (1) business, (2) education, (3) engineering, (4) library information and instruction, and (5) health, physical education, and recreation. Beginning with the 1998 issue, the journal became *The Journal of the Utah Academy of Sciences, Arts, and Letters*.

Annual Meeting: The Academy's annual meetings are normally held in the spring on one of the Utah campuses of higher education. The plenary session is called the Tanner Lecture, endowed by Mr. O.C. Tanner in 1986.

Best Paper Awards: The best paper presented in every division is given a cash award, which is presented at the Academy's "Awards Evening" held the following fall.

Distinguished Service Awards: The Academy recognizes outstanding contributions to teaching and scholarship by means of annual Distinguished Service Awards, alternating every other year between disciplines.

Membership: When the Academy was founded in 1908, membership was by nomination, ratified by the Council, and elected by a "three-fourths votes of members present." Today, the Academy's membership is available by application.

Institutional Members: All Utah institutions of higher education are members of the Utah Academy. The Academy appreciates their patronage.

Publication Policy

The *Journal of the Utah Academy of Sciences, Arts, and Letters* publishes works in all of the fields of study encompassed in the Academy's mission. Papers published in *The Journal of the Utah Academy of Sciences, Arts, and Letters* are drawn from papers presented by members in good standing at the annual conference of the Utah Academy. To qualify for publication, the papers must be recommended through a refereeing system.

Presenters are encouraged to publish their paper in *The Journal of the Utah Academy. The Journal's* criteria are that a submission is (1) fresh, meaningful scholarly insight on its subject; (2) readable and well written; and (3) of general interest for an academic readership beyond the author's field.

If you wish your paper to be considered for publication in The Journal, please submit a Microsoft Word document to the section editor of the appropriate section by the indicated deadline. Contact information for the section editors is available on the Utah Academy's website (www.utahacademy.org).

The Journal of the Utah Academy is a refereed journal. Editorial responses will be forthcoming after the resumption of school the following fall when referees have returned their comments to the division chairs.

Papers should be between ten and twenty double-spaced pages. Detailed instructions to authors are available at http://www.utahacademy.org/ Instructions_for_Authors.pdf.

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The Journal of the
Utah Academy of Sciences, Arts, & Letters—2012

AWARDS

ARTICLES

ARTS

BIOLOGY

DISTINGUISHED SERVICE AWARDS

Joyce Albrecht
 Utah State University

Mrs. Joyce Albrecht is the first lady of Utah State University and Development Director for the Caine College of the Arts. She brings nearly 35 years of administrative experience in higher education from two different states to her positions. Joyce began her professional career at Brigham young University, where she worked for 25 years and was recognized with the Ben E. Lewis Management Award. During this time, she provided 15 years of administrative oversight for the Utah Academy of Sciences, Arts, and Letters as Fiscal Officer and General Secretary. In 1995, Joyce moved to Gainesville, Florida, giving her the opportunity to work for the University of Florida Foundation, which ultimately exceeded its $1 billion campaign goal. In addition to her outstanding contributions professionally, community service has always been an important priority for Joyce. She volunteered countless hours at the University of Florida Shands Cancer Center and was recognized with the Outstanding Vounteer Service Award from Hope Loge, a home away from home for cancer survivors. Since her husband's assumption of the presidency at Utah State University in February 2005, Joyce has made students her top priority, hosting them at the President's House and tirelessly working to raise scholarship funds. The teas she has hosted throughout the state have raised much-needed scholarship dollars for the university's Women's Center. When Utah State University embarked on its first comprehensive capital campaign, Joyce continued to contribute to development through her stewardship of donors and assumed the position of Development Director for the Caine Colllege of the Arts, a newly formed college that has greatly benefitted from her expertise and leadership. Since the beginning of the campaign, over $30 million has been raised for student scholarships, faculty, and program support for the arts. Continuing with her lifelong tradition of community service, Joyce currently serves on the boards of the Cache Valley Center for the Arts, the Sunshine Terrace Foundation, and Intermountain Health Care of Logan. In her free time, Joyce enjoys reading, spending quiet time with her husband at their Florida home, and picnics in the park with her 12 grandchildren.

DISTINGUISHED SERVICE AWARDS

Steve Peterson
Snow College

Steve Peterson has been teaching English at Snow College for 35 years. During his tenure he has taught the standard composition courses as well as Literature of the Outdoors, Western American Literature, Introduction to Literature, and Survey of Film. In 1987-88, he taught at the University Technologi Mara in Kuala Lumpur, Malaysia, for SUNY Buffalo, and in 1996, he taught for a year at the Parker School on the Big Island of Hawaii. For the past eight years, he has directed the Snow College Convocation Series, bringing guest lecturers, artist, performers, and scientists to address Snow students and the Sanpete community every Thursday afternoon. He received the student-selected Outstanding Teach Award nine times, and in 2000 the Jessie Madsen Brady Superior Teaching Award for dedicated service. In 2007, Steve received the Snow College Outstanding Service Award for Touching Student Lives, and in 2011 the Utah Campus Compact honored him with the Civilly Engaged Scholar Award. He has served as chair of the English Department and Dean of Humanities at Snow. From 1992-1995, he worked as the first director of the Great Basin Environmental Education Center located east of Ephraim in the Manti-La Sal national Forest. Through cooperation with the USFS, the 100-year-old Great Basin Experiment Station was entirely renovated to accommodate groups of students and researchers for environmental education. Peterson served for six years on the board of directors of the Utah Humanities Council, for five years on the board of Entrada and Friends of Capitol Reef, and for five years as the chair of the Letters Division of the Utah Academy of Sciences, Arts, and Letters. From 1989 through 2006, he was the director of the Bennion Teton Ranch in Victor, Idaho, established in 1965 by Utah's father of civic engagement, humanitarian Lowell Bennion. During those 17 summers, over a thousand 12- to 15-year-old young men learned the value of service and hard work, along with appreciation of a simple life in the outdoors. Professor Peterson lives on a small farm in Spring City with his wife, artist Kathy Peterson.

ACADEMY FELLOW 2012

Craig J. Oberg
 Weber State University

A native of Oregon, Craig J. Oberg graduated from Weber State University (WSU) in 1979 and received his Ph.D. in 1985 from Utah State University. He then joined the Department of Microbiology at WSU and served as department chair for 21 years. Designated a Presidential Distinguished Professor of Microbiology in 2006, Dr. Oberg was the John S. Hinckley Fellow for 1998 and is the recipient at WSU of numerous other awards, including the Alumni Association's H. Aldous Dixon Award (1996), the George and Beth Lowe Innovative Teaching Award (1999), and the Spencer L. Seager Distinguished Teaching Award (2001). He was also the Cortez Honors Professor of the Year (2000) and the College of Science Endowed Scholar (2004–2007). An active researcher, Dr. Oberg has published more than 80 articles, has delivered over a hundred scientific presentations, has received numerous grants, and edited a book reconciling science and religion.

Dr. Oberg's eclectic interests as a scientist and intellectual have led him to such diverse projects as a book and honors course on fly-fishing (which received a half-page notice in the Sunday New York Times) and a summer in the highly selective Microbial Diversity Course at Woods Hole Marine Biological Laboratory. Wide-ranging curiosity has brought Dr. Oberg into research and writing projects on a broad spectrum, from an essay and photographic display on the microbiology of the thermal features of Yellowstone National Park to a book on cheese functionality, the outcome of a 25-year collaboration with Dr. Don McMahon. In this connection, he has helped develop several patents related to cheese production. In addition to all of this, Dr. Oberg has devoted considerable energy to service both on campus and in the professional community. He has served as president of the Utah Academy of Sciences, Arts, and Letters and of the Intermountain Branch of the American Society for Microbiology (ASM), and he is currently the Faculty Athletic Representative for WSU. He is also an active participant in the ASM and its Intermountain Branch and the American Dairy Science Association.

Dr. Oberg and his artist wife Lynette have five children and seven grandchildren and live in Liberty, Utah. Four of their children have graduated from WSU. Besides fly-fishing, his hobbies include running marathons, photography, hunting with his bird dog, and playing with the grandkids.

TANNER LECTURE AND
JOHN AND OLGA GARDNER PRIZE

Katharine Coles

Utah's Poet Laureate, 2006–2011
University of Utah

Katharine Coles is a professor of creative writing and literature at the University of Utah. Her fifth and sixth collections of poems, Reckless and Flight, are forthcoming in 2013 and 2015 from Red Hen Press. In addition to her four previous collections, The One Right Touch, A History of the Garden, The Golden years of the Fourth Dimension, and Fault (also Red Hen Press, 2008), she has published two novels, The Measurable World and Fire Season. Her work has been translated into Italian, Dutch, and Chinese. For 20 years, Coles has engaged in an ongoing collaboration with visual artist Maureen O-Hara Ure. The Red Butte Press has recently commissioned a fine, letterpress book from Coles and Ure. The Press will also produce a book illustrated by visual artist and printmaker Mary Toscano, based on one of Coles's Antarctica poems. Her poem "Numbers," commissioned by visual artist Anna Campbell Bliss, appears as a part of Numbers and Measures, a permanent installation in the Leroy Cowles Mathematics Building at the University of Utah. Another series, Passages, appears as a permanent intallation in Salt Lake City's Passages Park, for which Coles served as a member of the design team. Her poems have been set to music by composers Kurt Bestor, Steve Roens, and Dana Gress. During 2009 and 2010, Coles served as the inaugural director of the Poetry Foundation's Harriet Monroe Poetry Institute, a sort of think tank for poetry. As Institute director, she undertook three major projects: Poetry and New Media: A User's Guide; Best Practices in Fair Use for Poetry, a collaborative project with the Center for Social media at the American University; and Blueprints: Bringing Poetry to Communities (University of Utah Press and The Poetry Foundation, 2011), which she edited and cowrote. In late 2010, Coles traveled to Antarctica for a month to write poems under the auspices of the National Science Foundation's Antarctic Artists and Writers Program. Her forthcoming book, Reckless, comprises the poems from this project. Her interest in the intersections between poetry and science also led her to found the Utah Symposium in Science and Literature, which she now codirects with mathematician/biologist Fred Adler (www.scienceandliterature.org).

AWARDS EVENING LECTURE

Corey Christiansen
Utah State University

Corey Christiansen grew up in a musical family. His father, Mike Christiansen, has run the guitar program at Utah State University (USU) for over three decades. Corey spent a lot of his youth with his dad on campus learning about the guitar and music. Corey received his bachelor's degree from USU. A year later, Corey left for Tampa, Florida, to study with legendary jazz guitar educator, Jack Petersen. In 1999, Corey received his master's degree from the University of South Florida and took over Petersen's teaching duties the next year.

From 2000 to 2007, Corey was the senior editor and main guitar clinician for Mel Bay Publications. This job allowed him to tour, give clinics, develop products, produce recordings, and rub shoulders with the best musicians in the business. In 2007, Corey moved back to his native Utah as the Director of Curriculum for The Music School. During this time, he continued an active touring schedule playing all over the U.S. and into Europe. That fall, Corey signed with Origin Records, and he produced two records by 2008. His music draws on the tradition of the masters but leans towards the future. Corey's first two recordings, Awakening and MB3: Jazz Hits vol. 1, received ciritical acclaim and found success on North American radio. In Fall 2008, Corey assumed duties teaching full-time at USU and part-time at Indiana University where he'll be pioneering the jazz guitar program. Despite a busy academic schedule, Corey still tours and records.

Corey Christiansen has a number of publications with Mel Bay and has conducted countless guitar clinics and concerts across the country and beyond including Europe, South Africa and Australia. He has also performed at many notable festivals and venues including John Pisano's Guitar Night in Los Angeles, the Smithsonian Institution in Washington, D.C., the Umbria Jazz Festival in Perugia, Italy, the Lionel Hampton Jazz Festival, the Clearwater Jazz Festival, the Daytona Beach Jazz Festival, the Classic American Guitar Show, and the St. Louis Jazz Festival. He has also performed and/or recorded with many outstanding jazz artists including Jimmy Bruno, John Pisano, James Moody, Joe Negri, Willie Akins, Chuck Redd, Sid Jacobs, Jack Wilkins, Christian McBride, George Duke, Terri Lyne Carrington, Danny Gottlieb, and others.

HONORARY MEMBER

E.J. "Jake" Garn
 U.S. Senator, 1974–1993

Jake Garn was born in Richfield, Utah and attended Utah public schools. He is a graduate of the University of Utah, where he received a Bachelor of Science degree in Banking and Finance. In 1957, he married the late Hazel Thompson, and they had four children: Jake, Jr., Susan, Ellen, and Jeffrey. In 1977, he married Kathleen Brewerton, who had a son, Brook, from a previous marriage. They have a son, Matthew, and a daughter, Jennifer, 23 grandchildren, and three great-grandchildren.

Senator Garn served in the U.S. Navy as a pilot. He is a retired Brigadier General in the Utah Air National Guard and has logged more than 12,000 hours of pilot time. He is a former insurance executive and served as Mayor of Salt Lake City prior to his election to the U.S. Senate in 1974. He served six years as Chairman of the Senate Committee on Banking, Housing and Urban Affairs. He was a member of the Senate Appropriations Committee and served as Chairman for six years of the Veterans' Administration, Housing and Urban Development, and Independent Agencies Subcommittee. He also served on the subcommittees on Energy and Water Development, Defense, Military Construction and Interior. He was a member of the Energy and Natural Resources Committee and served on three subcommittees: Public Lands, National Parks and Forests; Research and Development; and Water and Power. He also was a member of the Senate Rules Committee and served three terms as Secretary of the Republican Conference. As Senator, he was re-elected to a second term in 1980 and a third term in 1986, with 74% of the vote in each election.

Senator Garn was invited by NASA to fly as a payload specialist on Flight 51-D of the space shuttle Discovery, which landed at Cape Canaveral on April 19, 1985, after orbiting the earth 109 times. During the seven-day mission, he performed various medical tests. In December 1992, Senator Garn received the very prestigious aviation award, the Wright Brothers Memorial Trophy.

Senator Garn retired in January 1993 from the U.S. Senate to return to Utah and is currently a self-employed consultant. He serves on the board of United Space Alliance (Houston). He is also involved with numerous local private/public sector endeavors that include Capmark Bank, BMW Bank of North America, Headwaters Incorporated, Franklin Covey, and Primary Children's Medical Center Foundation.

2012 BEST PAPER AWARDS

BIOLOGY

Molecular Characterization of Bacteriophages Isolated from the Great Salt Lake
Ryan Hoggan, Blake Dahl, Michele D. Culumber, Craig J. Oberg, and Matthew J. Domek, *Weber State University*

ENGINEERING

Jet Flow Behavior Observed During Microgravity Boiling
Troy Munro and Heng Ban, *Utah State University*

Multispectral Analysis of the Mangas Khipu Board
Madison Clark and Gene A. Ware, *Utah State University*

LETTERS—HUMANITIES, PHILOSOPHY, FOREIGN LANGUAGE

The Acquisition of Three Infinitival and Three Conjunctional Phrases: Establishing a Hierarchy of Difficulty
Rachel Kirk, *Southern Utah University*

LETTERS—LITERATURE

Shaw's Super(wo)man: Joan of Arc and Secular Saints' Plays
Jennifer Large Seagrave, *University of Utah/University of Phoenix*

PHYSICAL SCIENCE

The Effect of Surface Roughness on Reflected Intensity
Gregory R. Hart and Steven Turley, *Brigham Young University*

SOCIAL SCIENCE

Technology Use in Higher Education Classrooms
Kerry Kennedy, Brett Bartruff, Gina Brewer, and Mary Byra, *Weber State University*

A Fairey Tale: Pop, Presidents, and Propaganda

Courtney R. Davis
Utah Valley University

Abstract

This paper seeks to understand the duality and dichotomy of politically motivated pop art and the artists who have produced it. It addresses pop imagery as a mediator between the artistic creator and the mass consumer. Shepard Fairey's Obama "HOPE" poster (2008) and a recent "Occupy Wall Street" poster (2011) will provide a framework for considering the cult of the pop hero: While the former poster garnered near-universal praise, the latter has met with a markedly chilled public reception. Tarnished by a highly publicized copyright infringement lawsuit, Fairey seems to have reclaimed his roots as an activist, street-artist outsider, rather than a mainstream pop artist hero.

Introduction

In 2008, street artist Shepard Fairey produced perhaps the most recognizable presidential campaign poster in modern American history: a stylized image of Barack Obama positioned above the catchword

'HOPE' (Fig. 1). Adhering to a simple color palette of red, white, and blue, *HOPE* blends Fairey's undeniable pop influences with a signature Russian Constructivist twist to create an image that is graphic, readable, and highly memorable. Juxtaposed against the iconography of the Bush years, *HOPE* captured in one image the energy of a nation poised on the brink of a new beginning. In a letter of gratitude to Fairey, President Obama himself commented on the effect of the poster: "The political messages involved in your work have encouraged Americans to believe that they can help change the status-quo. Your images have a profound effect on people, whether seen in a gallery or at a stop sign."[1] Originally an independent work, HOPE was sanctioned by the official 2008 Obama campaign and quickly became an iconic image of the election. A mixed media version of *HOPE* was acquired by the Smithsonian Institution's National Portrait Gallery in 2009, stamping Fairey's work with the approval of the establishment.

Fig. 1. Shepard Fairey, Obama HOPE poster, 2008. Figure reproduced with permission from OBEY Giant Art.

But just three years later, Fairey would counter the establishment with an adaptation of *HOPE* created for the Occupy Wall Street movement. In this controversial image, dating to November 2011, Obama's face has been replaced with a Guy Fawkes mask, and the hope message

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[1] Carlo McCormick, "Street: Hopeful Disobedience," *Art in America* 97 (March 2009): 51.

incorporates a new slogan: "Mister President, we hope you're on our side." The artist also replaced the Obama "O" logo with a round insignia stating, "We are the 99%."

The new version, however, did not garner the accolades of the original *HOPE* poster. In fact, Occupy Wall Street affiliates even tried to distance themselves from the connotations of the image. One anonymous Occupy organizer went so far as to say, "[u]nfortunately, as it stands now, I myself and several other organizers cannot in any way be connected to this design."[2] Fairey responded to criticism with a revised poster and the slogan "We are the hope," explaining, "[t]he use of the word HOPE is more saying that Occupy is the greatest Hope we now have, but it would be great if Occupy pushed Obama in the right direction."[3] However, activists were still leery. In the months after the introduction of the posters, the press and bloggers alike commented on the image's chilled reception, as well as Occupy members' disavowal from and even annoyance with the poster intended to be their beacon of hope.

The reaction to the Occupy poster may not have been a matter of politics, but rather the fear of negative association with the artist. During Obama's term as president, Fairey transformed from fairytale street artist turned political media darling to fallen pop angel. The same year the Smithsonian ceremoniously acquired a version of *HOPE*, Fairey became embroiled in a very public copyright infringement lawsuit with the Associated Press (AP) over the photographic reference of Barack Obama used by Fairey. By no means a simple case, the lawsuit's progression was splashed across headlines and news blurbs, often stigmatizing Fairey as dishonest and disingenuous, a judgment exacerbated by a federal criminal contempt charge.

Perhaps it is actually befitting that *HOPE* would elicit such controversy. As an intermediary of popular culture, Shepard Fairey is faced with navigating the fickle tide of public taste, a charge intensified by the political nature of the artist's work. In this connection, this paper seeks to understand the duality and dichotomy of pop politics and why in some instances political propaganda, or pop-aganda, has been highly successful, and in other cases, dismissed as annoying or misleading. At the heart of this discussion is the attempt to understand *HOPE* within the construct of pop art, in an effort to determine whether there is a

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[2] Rosie Gray, "Shepard Fairey Changes Unpopular 'Occupy Hope' Poster Under Pressure," The Village Voice Blogs, entry posted November 22, 2011, http://blogs.villagevoice.com/runninscared/2011/11/shepard_fairey_6.php [accessed April 21, 2012].
[3] Ibid.

discernible message behind the silkscreen veneer of pop politics, or if the practical goal of pop artists is simply to elevate or advertise their own status in the eyes of mass culture, the all-important consumers. To understand the contemporary application of pop propaganda, it is necessary to consider the development of political messages in the pop art construct.

Pop and Pop-aganda: Precedence of the 1960s and 1970s

Cold War America provided the perfect setting for a visual invasion, not of militant fists and burning flags, but of dripping ice cream cones and floppy toilets, smiling celebrities and comic book glamour. Against the clearly delineated backdrop of Greenbergian Modernism, pop art roared into the early 1960s as a melding of high art and low art, turning mass culture and consumerism into museum-worthy art. Pop did not offer transcendence, sublimity, or spontaneous spiritual experiences; it was, as Andy Warhol once remarked, what "anybody walking down Broadway could recognize in a split second." Viewers were largely free from critical mediators, free to obey the new modern cult of image overload, transience, and capitalistic disposability. Indeed, with its seemingly empty imagery and apolitical coating of candy colors, pop was one of the more radical movements of the 1960s. Its subtle power of indoctrination introduced a passive brand of activism, one that was uniquely suited to transmitting potentially alienating messages, like political propaganda.

In the realm of politics, pop artists respected the comfort zones of their audience, transforming politically charged images into non-threatening mass consumables. Fighter planes, American flags, and presidential candidates all made regular rounds in pop art, albeit with a certain level of ambiguity. For example, James Rosenquist confronted consumerism, technology, and war with *F-111* of 1964, which features a fighter plane strangely situated near a child under a hair dryer. When originally exhibited at the Leo Castelli Gallery in Los Angeles in 1965, the oil painting was juxtaposed against vibrant images of tires, light bulbs, and twisting curls of spaghetti.

In 1969, the Leo Castelli Gallery, an early promoter of the pop movement, commissioned Jasper Johns to create a flag painting for the 1969 Moratorium Day. While Johns had been making paintings of American flags long before hippies starting burning them, he always placed the emphasis on process rather than message. The pop-inspired moratorium flag, however, became one of the most widely spread images of the Vietnam era. Bedecked with toxic hues of green, black and

orange, the flag is punctuated by a white dot—a single bullet hole. Artist and critic Debora Wood has noted that with this image, "Johns was able to successfully step outside the elitist art galleries [and] into the street culture to create work designed to raise society's consciousness."[4]

Pop artists, like Rosenquist and Johns, walked the tenuous line between *reflecting* popular culture and *shaping* popular culture. As the style gained momentum, the celebrity of pop artists was on occasion directed to more partisan causes. For example, Andy Warhol produced *Vote McGovern* for the 1972 presidential election. Although the image depicts Richard Nixon, it was actually intended to support his opponent, George McGovern, whose name is scrawled across the bottom of the work. *Vote McGovern* depicts Nixon bathed in a lurid green hue, with yellow lips and background, and a lipstick pink suit. While the work raised $40,000 for Senator George McGovern's presidential campaign, the ambiguous image actually scored votes for both candidates and earned Warhol yearly tax audits for the rest of his life.

Despite the Nixon ambiguity, Jimmy Carter commissioned Andy Warhol in 1976 to create an image for the next presidential election race, acting as if the artist himself was the grantor of popular appeal. As curator Sharon Atkins noted, this manipulation of public persona "was a very directed attempt … to reach the younger voters, and the voters of New York. It was a political hopeful deliberately using Warhol's celebrity and status to try to position himself as a progressive candidate."[5] However, the bland Carter images seem indistinguishable from Warhol's slew of 1970s celebrity portraits. The focus is less on political message and more on *au courant* popular culture, thus diluting the Carter portraits as political propaganda.

A much more successful pop subject was Carter's successor, actor-turned-politician Ronald Reagan. The image of the jelly-bean-loving president painted by a notorious sweet tooth, *Van Heusen (Ronald Reagan)* of 1985 was a perfect marriage of celebrity and sugarcoated American pop culture. In regal pop art fashion, Warhol appropriated an image for the portrait from a men's shirt advertisement that had originally been used in promotion of Reagan's 1953 film, *Law and Order*.[6]

[4] Debora Wood, "Art and Transformation," *Issues in Integrative Studies* 16 (1998), 65.

[5] Julia Ann Weekes, "Warhol's Pop Politics," Smithsonian.com, posted October 31, 2008, http://www.smithsonianmag.com/arts-culture/Warhol-Pop-Politics.html [accessed April 21, 2012].

[6] Robert Paul Metzger, *Reagan: American Icon* (Lewisburg, PA: Bucknell University, Center Gallery, 1989), 14.

Because of its pronounced subtly, political pop imagery is more powerful than viewers often realize. Pop art—like propaganda itself— draws its power from advertising ideas to a mass audience. Portraits and political commentary transform into slick, consumable images suitable for glossy magazines and towering billboards. Because of this, typography often played an important role in detailing the pop message, which could be either negative or positive. While Andy Warhol, Jasper Johns, and James Rosenquist all used some kind of text in their works, none reached the iconic results of Robert Indiana.

Pushing back against the violence of Vietnam, Robert Indiana's LOVE imagery would come to define an entire era. During the early 1960s, Indiana experimented with hard-edged textual and numerical imagery, not unlike that of precisionist Charles Demuth. Using the power of text, Indiana's works were far from neutral, like *The Rebecca* (1962), which includes the words "Port of New York: The American Slave Company" or his 1965 *Confederacy* series, which referenced attacks on civil rights demonstrators. But Indiana's breakout image was far less political. In 1965, the Museum of Modern Art commissioned Indiana to create a design for one of the museum's Christmas cards. Although the resulting LOVE image was intended as an homage to the artist's father,[7] the design hit a chord with the 1960s American youth culture and the rise of the love movement. With LOVE acting like an itinerant traveler, to borrow an analogy from biographer Susan Elizabeth Ryan, Indiana was a "self-styled 'people's painter,'"[8] and he participated in collaborations to create LOVE rings, LOVE tapestries, LOVE album covers, and LOVE serigraphs.

In this connection, LOVE almost became a brand, melding into the public consciousness of Vietnam Era America. But the saturation of LOVE imagery would not only hinder critical appreciation, it would also present a formidable challenge for copyright regulation. Appropriations of LOVE abounded in the late 1960s, and Indiana faced the almost impossible challenge of enforcing his copyright.[9]

Based on lessons of the past, it appears that politically and/or socially motivated pop art faces two prominent challenges: 1) ambiguity of message, and 2) the risk of copyright infringement. While Robert Indiana struggled to maintain control over his design, Shepard Fairey fought a different copyright battle—that of proving originality. Al-

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[7] Susan Elizabeth Ryan, *Robert Indiana: Figures of Speech* (New Haven: Yale University Press, 2000), 206.
[8] Ibid., 219.
[9] Ibid., 222.

though his work drew inspiration from Andy Warhol, Soviet propaganda, and even Robert Indiana's *LOVE*, it was the image of President Obama that caused the AP to cry foul.

Pop Goes Legal

Appropriation has always played a key role in pop art. Indeed, it is difficult to imagine Pop without the inclusion of everyday objects, street signs, and celebrities. In recent years, copyright owners have become more aggressive with raising infringement lawsuits. For example, contemporary artist Jeff Koons, best known for his monumental stainless steel balloon animals, famously lost a copyright infringement case in 1992 for creating a three-dimensional derivative work from a postcard image of puppies.[10] More recently, photographer Richard Prince lost a copyright infringement case for using the photographic images of Patrick Cariou in his collages.[11] Photography was also at issue in the case of Shepard Fairey.

In the case of *HOPE*, the AP claimed copyright ownership of the photograph that Fairey used as inspiration for the poster without obtaining a license or giving credit. In an unusual strategic maneuver, Fairey first brought suit against the AP in 2009, preemptively requesting a federal judge to find his use of the Obama image was not in copyright violation. The AP counter-sued, identifying in their complaint other alleged misuses of copyrighted works by Fairey. In October of the same year, Fairey admitted to fabricating and attempting to destroy evidence in an effort to strengthen his fair-use case. In January 2011, the parties finally settled their copyright claims against each other, and an agreement was reached in March 2011 regarding Fairey's Obey clothing line, which also used AP imagery. The exact terms of the agreements remain confidential.

While battling the powerful AP seemed at first like the defiant act of an underdog fighting against deep-pocketed corporate America, the idyllic scenario quickly turned awry when Fairey was accused of falsifying evidence. In February 2012, Fairey pleaded guilty to contempt, and he was sentenced in September, receiving two years probation and a $25,000 fine. Regarding Fairey's actions, U.S. Attorney Preet Bharara remarked that the artist "went to extreme lengths to obtain an unfair and illegal advantage in his civil litigation, creating fake documents and destroying others in an effort to subvert the civil discovery proc-

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[10] *Rogers v. Koons*, 1960 F.2d 301 (2d Cir. 1992).
[11] *Cariou v. Prince*, 784 F. Supp. 2d 337 (S.D.N.Y. 2011).

ess."[12] But given this tumultuous court battle, it is perhaps not surprising that Fairey's recent Occupy Wall Street poster has not been received with the same degree of warmth as was *HOPE*.

Against this backdrop, however, Fairey's legal battles seem to have increased, not diminished, the artist's role as an intermediary of public taste. His highly publicized court battle with the AP fed the public interest with scandal, celebrity, and legal drama. The fluctuation of public taste could even be compared to President Obama's own approval rating. In this connection, the author proposes that this "Fairey Tale" correlates to the pop culture fascination with the cult of the hero.

Pop Culture and the Cult of the Hero

From comic books and blockbuster films to news bites and viral videos, popular culture is fixated with both creating heroes and with destroying them. The concept of the hero, like a Platonic ideal, represents the best of humanity, those who excel in times of turmoil and tragedy, like Nazi-occupied Europe, the civil rights movement of the 1960s, and, of course, 9/11. In the words of Scott T. Allison and George R. Goethals, who recently published a book on the subject, "[h]uman beings inherently know that there is nothing to admire about a person who effortlessly succeeds. The struggle makes the hero."[13]

In popular culture, this heroic struggle is often linked to celebrity and media coverage; the music industry is particularly rich with the practice of creating celebrity demigods. Interestingly, Shepard Fairey himself has commented on the power of music, asserting that "Art is just outgunned in the battle for the senses … Music provides a cultural eco-system in and of itself. There's the actual music, the lyrics with their content and politics, the style and personalities of the bandmembers [sic] and the politics implicit in their lifestyles, and lastly, their art, album packaging and graphics.[14]

The crossover between heroic musical anthems and visual imagery has provided a fertile ground for a particular kind of pop propaganda. The connection between the celebrity-performer-hero and

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[12] U.S. Department of Justice, "Artist Shepard Fairey pleads guilty in Manhattan Federal Court to contempt charge in connection with civil litigation over Obama 'Hope' poster," http://www.justice.gov/usao/nys/pressreleases/February12/faireyshepardplea.html [Accessed April 21, 2012].

[13] Scott T. Allison and George R. Goethals, *Heroes: What They Do & Why We Need Them* (Oxford University Press: 2011), 119.

[14] Shepard Fairey, "Propaganda Essays: Heroes," http://obeygiant.com/essays/heroes [Accessed April 21, 2012].

contemporary politics was cemented long ago, coming of age in the 1960s and remaining a rock music staple ever since. Songs have become anthems, lyrics like manifestos as musicians give a single, unified voice to the masses. In 2004, for example, alternative punk band Green Day released *American Idiot* (Reprise Records), the band's seventh studio album, which would receive innumerable accolades, including a Grammy for Best Rock Album and even a Broadway musical adaptation. More than a collection of songs, the album is a thematic program, telling the story of Jesus of Suburbia, "Whatsername," and Saint Jimmy, the rebel freedom fighter. *American Idiot* struck a chord with alternative and popular music enthusiasts alike, as it was almost impossible not to connect the title track to the socio-political struggles of the Bush years, with lyrics referencing mass media, propaganda, and the information age of hysteria.

The video released for *American Idiot* drew from bombastic pop culture imagery, even giving a subtle nod to pop artist Jasper Johns, with an image of a dripping green American flag. This lurid shade of green is more than Green Day's signature color, it is a hue charged with negativity in contemporary culture. The color of radioactivity, aliens, and devilishness, sharply saturated green tones function as a warning sign, as seen in Warhol's image of Nixon.

Working through such forms of media as music videos, gallery paintings, and street art, pop influences have functioned as shorthand for mass communication. The symbiotic relationship of pop artist and pop culture works in an endless cycle, one supporting the other. The creators of pop iconography often become imbued with the mantle of heroism, as if they are enlightened individuals, rebelling against the same status quo they reflect in their own work.

Fairey operated within this construct with his original *HOPE* poster, which perfectly complimented Obama as a nontraditional candidate. One can surmise that this is exactly what Carter was hoping for when he commissioned Warhol in 1976. Interestingly, although Warhol and Fairey could both be classified as pop artists, one important factor separates them: While the former had already been assimilated in the annals of art royalty and would leave a $500 million estate at his death in 1987, the latter is still classified in news articles as a street artist.

Street art is still a dodgy subject in the realm of art history, aesthetics, and formalism. The concept is so proletariat that critics often struggle with including these outsiders in the canon of art history, particularly because their work is often stigmatized with the tags of vandalism, trespass, and the destruction of property. In 2009, for example, Shepard pleaded guilty to one count of defacing property and two counts of wanton destruction of property in Boston for placing a poster

on an electrical box. But the inherent danger of being a Shepard Fairey or a Banksy adds to the heroic nature of their work, work that is both image driven and performance based.

The edginess of Fairey is not simply relegated to street art, but is also a part of his work as an advertiser and graphic designer. Carlo McCormick has noted, "given his penchant for mass saturation and the social nature of his activities, every Fairey campaign (political or commercial) has a proven ability not just to get people to look but to buy, identify, wear, participate and spread the message, even when it could mean that they themselves might be breaking the law."[15] In many ways, pop culture feeds on the idea of civil disobedience for the greater good, the storyline of countless movies, where a disempowered "Every Man" takes on the system. But at the same time, the rebel-hero cannot be too extreme and still be idolized by pop culture, which can tolerate only diluted forms of activism. The Occupy Wall Street poster runs afoul of this unwritten pop law.

For the 2011 poster, Shepard Fairey appropriated the Guy Fawkes mask from *V for Vendetta*, the 1980s comic series by Alan Moore and David Lloyd, adapted to the big screen in 2005. The fictional V, an anarchist from post-Nuclear London, wore a Guy Fawkes mask to protect his identity, Fawkes being famed for the failed Gunpowder Plot of 1605 meant to blow up the House of Lords. Because of its connotations, Occupy protesters readily adopted the mask for public demonstrations (Fig. 2). By appropriating the *V* mask, Fairey seems to sidestep the comfort zone of pop culture with an image that could be read as a seditious call of revolution to the 99%.

Fig. 2. Lee Hassl, Occupy Wall Street protesters, 2011. © Lee Hassl, 2011. Figure is reproduced under the Creative Commons Attribution-ShareAlike 3.0 unported license

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[15] McCormick, 53.

As an activist work, the Occupy poster is highly successful. But as a pop art image, it is just the opposite: It runs afoul of the cult of the pop hero. Like many pop artists, Fairey is difficult to trust. While his imagery often questions authority, the media, and consumerism, he also operates directly within that construct. Like Andy Warhol once was, Fairey is also a commercial artist, creating imagery to sell products. The Saks Fifth Avenue "Want It" campaign of 2009, for example, exploited the artist's signature Russian Constructivist style to sell expensive clothing and accessories, rather than presidents. Given his role in pop culture, we cannot help but wonder, is Shepard Fairey an activist, ready to push against authority no matter the risk? Or do his strengths lie in advertising, rather than activism, the advertisement of presidents, ideas, or even his own career? Or perhaps ambiguity itself is the point, perhaps Fairey wants us to question him, just as he has questioned us.

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Isolation of Novel Phage from the Great Salt Lake that Infect *Idiomarina*

Carlie M. Benson, Craig J. Oberg,
Michele D. Culumber, and Matthew J. Domek
Weber State University

Abstract

Characterization of euryhalophilic bacteria from the south arm of the Great Salt Lake (GSL) showed a number of bacteria in the genus Idiomarina. *Since bacteriophages (phages) play a role in controlling bacterial populations and facilitate lateral gene transfer, we tested GSL water samples against four* Idiomarina *isolates for phages. Initial screening showed a large number of plaques with a wide range of morphologies. Plaques were grouped into four categories based on plaque morphology: 1) plaques with a 10-mm-diameter clear zone and a much larger opaque halo extending around each plaque; 2) plaques of 2-mm diameter; 3) plaques of 1-mm diameter; and 4) plaques with nonuniform shapes. A host range performed with purified phage isolates against several Idiomarina strains indicated we have isolated five different phage types. The 16S rRNA gene sequences of these* Idiomarina *strains had < 0.5% difference over 1,300 base pairs (bp), indicating*

phage typing may provide greater strain resolution than 16S rRNA sequencing. There appears to be some correlation between plaque morphology and host range. Restriction digests of genomic DNA from two phages CB13, which infects host S3, and CB04, which infects host S11, indicate that although the hosts are closely related, the phages that infect them are not. Sequence analysis confirms that these phages are unique. CB13 has a genome of ~45 kbp, and CB15 has a genome of ~78 kbp. Preliminary analysis reveals unique and novel open reading frames in each genome.

Introduction

The Great Salt Lake (GSL) is a naturally occurring hypersaline environment containing a wide diversity of euryhalophilic to extremely halophilic microorganisms (Baxter et al. 2005). High concentrations of sodium chloride (NaCl) and nutrients, consistent sunlight exposure, and wind-generated aeration allow the GSL to support a dense population of halophilic microorganisms (Ventosa 2006). These microorganisms contribute significantly to the ecological balance in this saline lake because they form the base of the food chain, act as decomposers, and participate in the recycling of basic nutrients (Dyall-Smith et al. 2005).

Most characterized species of the genus *Idiomarina* are from thalassohaline (seawater-derived) environments, including species isolated from deep-sea vents (4000–5000 m below sea level) (Ivanova et al. 2000). Several species have been isolated from hypersaline environments and exhibit a NaCl growth range of 1–15% wt/vol with optimum growth at 5% wt/vol NaCl (Kwon et al. 2006; Yeon et al. 2005). They are gram-negative rods that grow aerobically and are motile by a single polar or subpolar flagellum (Donachie et al. 2003). Genome comparison studies indicate this bacterium has maintained its amino acid transport and degradation systems, but has lost sugar transport and certain sugar metabolic genes, suggesting it lives on amino acids rather than sugars (Donachie et al., 2003). This observation suggests GSL *Idiomarina* strains may preferentially utilize protein products from the degradation of brine shrimp and brine fly carcasses, a possible explanation for their adaptation to the GSL environment. The *Idiomarina* genus has a unique isobranched fatty acid composition, unlike other *Gammaproteobacteria*, which could play a role in adaptation to higher salinity (Brettar et al. 2003). The GSL isolates used in this study are most closely related to *Idiomarina loihiensis*, which grows optimally in salt concentrations of 7.5 to 10% wt/vol, similar to the salinity of the GSL's South Arm, the location where they were isolated (Donachie et

al. 2003). This is the first detailed report of *Idiomarina* being isolated and characterized from the GSL, and preliminary plating studies suggest they may comprise a significant portion of the GSL microbial community (data not shown). As such, they make a likely host to be used for bacteriophage isolation.

Bacteriophages (phages) are viruses that infect bacteria and are thought to help maintain equilibrium between bacteria and nutrient resources and between related bacterial species (Rodriguez-Brito et al. 2010). Phages play an important role in recycling nutrient biomass in their environment. Phages can also mediate transduction, lysogenic conversion, and species successions and help maintain microbial diversity (Jiang et al. 2004). The significance of these roles in the microbial ecology of the GSL requires the isolation of host/phage systems. Bacterial predation by phages may be a significant source of bacterial mortality in hypersaline environments where protozoal grazing is limited (Dyall-Smith et al. 2005), but there are few reports of bacterial predation by phages in the unique microbial environment found in the GSL (Kauri et al. 1991). One reason for this is the lack of well-defined host/phage model systems expressly isolated from the GSL so bacterial predation studies can be initiated.

Previous studies characterizing halophilic bacteria from the South Arm of the GSL showed a high concentration of *Idiomarina* isolates. There are very limited reports of phages specific to this genus, with only one phage isolate reported from a halophilic environment (Jiang et al. 2004). Sampling Mono Lake (only 70–85 g/L NaCl as compared with the GSL South Arm at 120 g/L NaCl), researchers isolated phage FMono1 with an *Idiomarina* host closely related to *Idiomarina baltica*. No phages isolated or identified in the GSL that infect *Idiomarina* have been reported. In this study, we sought to determine whether GSL-isolated *Idiomarina* strains are susceptible to phage predation from phages present in the GSL and to examine the relatedness of any phage isolates.

Materials and Methods

Media

An oligotrophic halophilic hedium (HM) broth was prepared by modifying the halophilic broth (HB) recipe (Atlas 1993) to contain less sodium chloride (NaCl) and a decreased concentration of several nutrients. The modified HB had the following formulation per liter: NaCl, 80 g; $MgSO_4 \cdot 7H_2O$, 25 g; casamino acids, 5 g; yeast extract, 5 g; protease peptone, 2.5 g; KCl, 2 g; trisodium citrate, 3 g. HM agar (HMA) was supplemented with 1.5% agar for agar plates, and HM soft agar

(HMSA) was supplemented with 0.5% agar for plaque assays. HM 2X broth contained twice the amount of each chemical component of HM, except NaCl, which remained at 8%. Prior to sterilization, the final pH was adjusted to 7.2 using 1 N NaOH for all HM media.

Bacterial cultures

Four isolates, originally isolated from water samples taken from the South Arm of the GSL, were used for this phage isolation/characterization study. All bacterial cultures were incubated for 24 hr at 30°C in HM broth prior to use.

16S rRNA gene sequencing

DNA was extracted from the isolates using the MoBio Ultra Clean Microbial DNA Extraction Kit (MoBio, Carlsbad, CA). The 16S rRNA gene was amplified using bacteria specific primers (27F 5' AGA GTT TGA TCM TGG CTC AG 3'/1492R 5' ACG GYT ACC TTG TTA CGA CTT 3') (Lane 1991). The reaction mixture contained 200 nM of each primer, 200 µm of the dNTPs, 1U DNA Taq Polymerase, and the diluted reaction buffer (Promega Corp., Madison, WI). The amplification conditions were 94°C for 3 min, followed by 25 cycles of 94°C for 45 sec, 50°C for 1 min, 72°C for 2 min, and a final extension step at 72°C for 7 min. Sequencing was done by the Idaho State University Molecular Research Core Facility (Pocatello, ID). The sequences were compared to the NCBI GenBank database using Basic Local Alignment Search Tool (BLAST).

Isolation of phages from GSL water samples

Water samples from the South Arm of the GSL at Bridger Bay were collected and centrifuged at 3000 rpm for 15 min. The supernatant was filtered through a 0.45-µm filter followed by a 0.20-µm filter (250-mL Filter System, Corning, NY). One milliliter of the 0.2-µm GSL water filtrate and 500 µL of a host *Idiomarina* isolate were combined with 4 mL of HMSA then poured over HMA plates (soft agar overlay method). These plates were incubated for 24 hr at 30°C before examining for plaques (clear zones in the soft agar overlay indicating a phage infection of the host bacteria).

Enrichment method for isolation of phages

When a phage for a specific *Idiomarina* isolate could not readily be found, phage enrichment cultures were made by combining 5 mL of

HM 2X, 5 mL of GSL filtrate, and 1 mL of the specific *Idiomarina* host culture in a sterile 100-mL flask and incubating at 30°C for 24 hr. Phage enrichment cultures were compared with a control containing only HM and *Idiomarina* host, but no GSL filtrate. A positive result for a phage enrichment culture was indicated by reduced turbidity when compared with the control. Phages from the enrichment cultures were harvested by centrifuging the enrichment broth at 5,000 rpm for 5 min to sediment bacterial cells. The supernatant was filtered using a 0.45-µm filter to remove the majority of suspended bacteria, followed by a 0.2-µm filter to remove any remaining bacteria. The filtrate was serially diluted in 8% wt/vol sterile saline, and a titer was done using the soft agar overlay method as previously described to look for plaques.

Isolation of phages from plaques

Individual phages were isolated by harvesting agar plugs from the center of a plaque using a sterile Pasteur pipette. Three to five agar plugs were harvested from each plaque. The agar plugs were placed in 1 mL of a sterile 8% NaCl solution, and the phages were allowed to diffuse out of the agar for 12 hr. The solution was then filtered through a 0.45-µm filter and then a 0.2-µm filter to remove any remaining bacteria.

Host range determination

Three techniques were used to characterize phage types and to define host range for the phage isolates. First, plaque morphology was observed. Five hundred microliters of each *Idiomarina* GSL isolate was combined with 500 µL of a purified phage isolate and incubated for 15 min to allow for phage attachment.   After incubation, the phage/host mixture was serially diluted in 8% sterile saline, and 500 µL of each phage/host dilution was added to 4 mL of molten HMSA at 52°C and poured over HMA plates. Second, spot tests were done to identify host range. Five hundred microliters of each *Idiomarina* GSL isolate was combined with 4 mL of HMSA, poured over HMA plates, and allowed to solidify. Three microliters of each purified phage isolate was applied to the inoculated soft agar in defined locations across the Petri plate. Third, streak tests were used as a rapid method for confirming and comparing host range of different phage. *Idiomarina* host isolates were diluted 1:10 in sterile 8% NaCl. HMA plates were prepared by applying three streaks of diluted *Idiomarina* host across the length of the agar, one streak for each host isolate. A 2-µl droplet of a purified phage isolate was applied to discrete sections of each streak. Petri plates were incubated at 30°C for 24 hr.

Phage purification

Phages were purified by combining 30 mL of phage stock with 7.5 mL of 20% PEG-8000. The mixture was incubated on ice for 30 min and centrifuged at 11,000g for 20 min. The supernatant was removed, and the tubes were centrifuged 2 more times to remove all of the polyethylene glycol solution. The pellet was resuspended in an appropriate volume (500–1000 μl) of STE buffer (Sambrook et al. 1989), transferred to a microfuge tube, and centrifuged at 14,000g for 10 min. The supernatant was then transferred to a new microfuge tube for DNA isolation (Sambrook et al. 1989).

DNA isolation

Pancreatic DNase I and RNase (Sigma-Aldrich, St. Louis, MO) were added to the purified phage solution to final concentrations of 5 μg/mL and 1 μg/mL, respectively, and incubated at 37°C for 30 min. A phage digestion solution (ethylenediaminetetraacetic acid (EDTA) from a 0.5 M stock solution (pH 8.0), proteinase K, and sodium dodecyl sulphate (SDS) from a 10% wt/vol stock solution diluted to a final concentration of 20 mM, 50 μg/mL, and 0.5%, respectively) was then added. The tube was mixed by inverting several times and incubated at 56°C for 1 hr. The digestion mixture was cooled to room temperature, and an equal volume of phenol, equilibrated with 50 mM Tris (pH 8.0), was then added. The tube was mixed by inverting it several times until a complete emulsion formed. After centrifugation at 3,000g for 5 min, a sterile wide-bore pipette was used to transfer the aqueous phase to a new tube. A second extraction of the aqueous phase was done by adding an equal volume of 50:50 phenol/chloroform to the aqueous phase following the above protocol. A final extraction was done with an equal volume of 1:24 isoamyl alcohol/chloroform added to the aqueous phase, and the aqueous phase was then recovered as previously described. Sodium acetate from a 3 M stock solution (pH 7.0) was added to a final concentration of 0.3 M, followed by 2 volumes of cold 95% ethanol. The solution was mixed and stored at room temperature for 30 min to allow DNA to precipitate. Phage DNA, seen as a threadlike precipitate, was removed on the end of a sterile Pasteur pipette. The DNA was transferred to a microfuge tube containing 1 mL of 70% ethanol and recovered by centrifugation at 12,000g for 2 min at 4°C. The pellet was allowed to dry at room temperature then resuspended in an appropriate volume of DNA storage buffer (pH 7.6) (Sambrook et al. 1989).

Restriction endonuclease digestion

Each phage DNA was digested with EcoRI, Hind III, and BamHI restriction endonucleases (Promega Corp., Madison, WI) following standard protocol (Sambrook et al. 1989). Fragments were separated on a 1.25% agarose gel run at 70 V for 4 hr. DNA digests were stained and visualized with ethidium bromide and photographed.

Genome sequencing

Phage genomes were sequenced using a Roche 454 Pyrose-quencer at 100× coverage, and preliminary annotations were done using RAST (http://rast.nmpdr.org).

Results

16S rRNA gene sequencing

Genetic analysis of the 16S rRNA for the GSL *Idiomarina* isolates revealed that all four strains were closely related to *Idiomarina loihiensis*, originally isolated from a submarine volcano off the coast of Hawaii (Donachie et al. 2003) (Fig. 1).
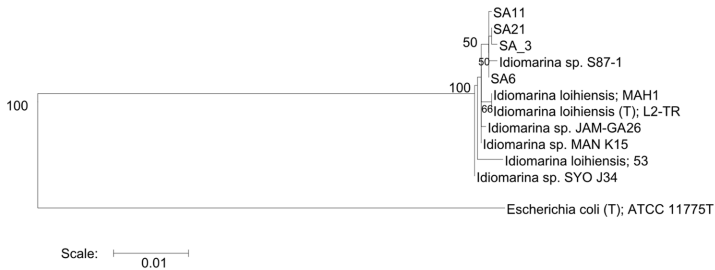
Fig. 1. Neighbor-joining phylogeneitc tree comparing *Idiomarina* strains (designated SA) isolated from the GSL with known *Idiomarina* species (scale indicates changes per base). The tree was constructed with The Ribosomal Database Project 10 (www.rdp.cme.msu.edu). Numbers at the rods indicate bootstrap replicates supporting the tree.

Isolation of phages from GSL water samples

Initial screening showed that a large number and variety of plaques developed on several of the GSL *Idiomarina* isolates. One group of plaques formed a 10-mm clear zone with a much larger

opaque halo extending around each plaque (Fig. 2a). A second group of plaques were small (2-mm diameter). A third plaque morphology was the smallest with only a 1-mm diameter, while a fourth group of plaques had variable morphologies (Fig. 2b). Plating of phages with variable sized plaques was repeatable, even when a single plaque was harvested and purified before plating. Aside from the last group of phage, plaque morphologies consistently appeared on their respective bacterial host strains as individual phages were isolated, purified, and propagated.
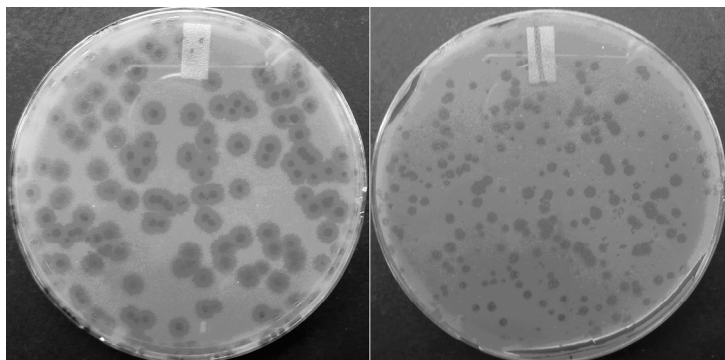
Fig. 2. Plaque morphologies for *Idiomarina* bacteriophages isolated from the GSL. (a) CB13 on SA03; (b) CB04 on host SA11.

Host range determination

Initial host range results revealed phage isolates that can be tentatively placed into five different groups (Table 1). One group of phage (isolates 11, 12, 13, 15, and 16) could only infect *Idiomarina* S3. A second group of phage (isolates 2, 3, 6, 10, and 14) could infect two different hosts, *Idiomarina* S3 and S11. The third group of phage (isolate 9) infected both *Idiomarina* S3 and S21, while a fourth phage group (isolate 8) only infected *Idiomarina* S21. The fifth group of phage (isolates 1, 4, 5, and 7) was found to infect only *Idiomarina* S11. Recently, a potential sixth phage group was discovered that only infects *Idiomarina* SA06 (phage CB89).

Genome sequencing and restriction digest characterization

Three *Idiomarina* isolates from the GSL are nearly 99.5% identical over the 16S rRNA gene (Fig. 1), yet phage CB04 only infected S11

Table 1. Host range of *Idiomarina* bacteriophages isolated from the Great Salt Lake				
Phage Isolates	**Host Strains** (*Idiomarina* **GSL Isolates**)			
	SA03	**SA06**	**SA11**	**SA21**
Group 1				
11	X			
12	X			
13	X			
15	X			
16	X			
Group 2				
2	X		X	
3	X		X	
6	X		X	
10	X		X	
14	X		X	
Group 3				
9	X			X
Group 4				
8				X
Group 5				
1			X	
4			X	
5			X	
7			X	
Group 6				
89		X		N/A

and phage CB13 only infected S03 as confirmed by the streak test (Fig. 3). Enzymatic digests revealed they were both DNA phages and sug gested that their genomes are ~50–55 kb. Restriction digests using three different restriction endonucleases showed no similarity in banding patterns between the phages' DNA for any of the restriction enzymes (Fig. 4). Initially, phage CB13 and CB15 (phages that only infect SA03) were thought to be the same phage, but genome sequencing of CB13 and CB15 revealed they are quite different. CB13's genome is

~45 kb while the genome of CB15 is >78 kb in length, and there is very little similarity in open reading frame patterns between the two phages (Fig. 5).
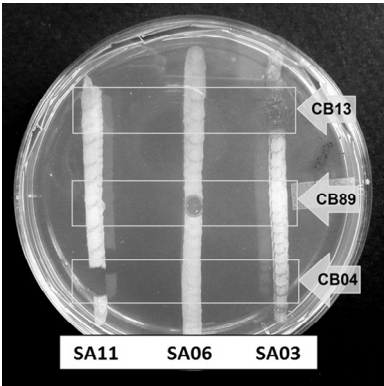
Fig. 3. Three *Idiomarina* bacteriophage isolates were spotted on three *Idiomarina* isolates from the GSL to determine their host range using the streak test procedure.

Fig. 4. Agarose gel electrophoresis comparing the restriction digest banding patterns for *Idiomarina* GSL bacteriophages CB04 and CB13. (Lane 1, CB04 with HindIII; lane 2, CB04 with BamHI; lane 3, CB04 with EcoRI; lane 4, λ phage DNA with HindIII; lane 5, CB13 with HindIII; lane 6, CB13 with BamHI; lane 7, CB13 with EcoRI; lane 8, DNA Ladder).

Fig. 5. Comparison of genome annotations for phages CB13 (top) and CB15 (bottom).

Discussion

This is the first report of *Idiomarina* strains being isolated from the GSL and the first report of phages isolated from the GSL that infect these euryhalophilic *Idiomarina* isolates. Genetic characterization of *Idiomarina* strains from the GSL suggests they are more closely related to species found in deep-sea vents than to species isolated from hypersaline environments (Choi and Cho 2005; Ivanova et al. 2000). This may be due to the unusual chemical environment of the GSL, particularly in respect to the concentration of different ions in the water besides NaCl, which may be more similar to the water chemistry found near deep-sea diffuse-flow hydrothermal vents (Choi and Cho 2005).

Plaque morphology suggests possibly five unique phage types have been isolated that infect *Idiomarina* bacteria present in the GSL. Initial screening showed a large number and variety of plaques developed on the four GSL *Idiomarina* isolates. A comparison of plaque morphologies suggested that a number of the phage isolates could be grouped together based on the diameter and turbidity of the plaques they produced. Although not a definitive taxonomic tool, plaque morphology is usually unique and, in our observations, reproducible with each host, making it a valuable screening tool.

A more definitive grouping resulted when a host comparison was used to identify which phage isolates infected each of the four *Idiomarina* host strains. Host analysis indicated at least six different phage types might be present in the GSL that can infect GSL *Idiomarina* strains. There appears to be some correlation between plaque morphology and host range for the five groups.

Three *Idiomarina* strains obtained from the GSL appear to be almost identical, yet phages can be found in the GSL that are unique for each isolate based on phage genome restriction digests. However, two distinct phages with the same host range, CB13 and CB15, were found, demonstrating that multiple phages exist for the host species. The genomes of these two phages were quite different. Potential hypothesis for this difference may be related to the need for increased specific phage predation during times of seasonal high cell density, competition between closely related species, or acquisition of phage resistance by some *Idiomarina* strains. Another possible explanation for such a large number of phage types may be the lack of protozoal grazers in the GSL (Post 1977), necessitating a more robust population of phages that can respond to changes in bacterial populations. This hypothesis needs to be examined now that a phage/host system has been developed for *Idiomarina*. This, and future studies, will facilitate our understanding of the role phages have in the lake's microbial ecology.

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Molecular Characterization of Bacteriophages Isolated from the Great Salt Lake

Ryan Hoggan, Blake Dahl, Michele D. Culumber, Craig J. Oberg, and Matthew J. Domek
Weber State University

Abstract

Salinivibrio costicola *is a moderately halophilic Gram-negative motile bacterium, which has three bacteriophage strains reported in the literature that are known to infect it. One of these strains, NS01, was discovered and isolated from the Great Salt Lake (GSL). Recently, a new bacteriophage, CW02, was isolated from the GSL, which is also found to infect* S. costicola. *In this study, we compared NS01 with the newly isolated CW02 to determine the nature of their genomes and to determine whether they are unique bacteriophages or simply different strains of the same bacteriophage.* S. costicola *strains (SA39 and SA50) were isolated from the South Arm of the GSL. The 16S rRNA gene sequencing showed they were closely related (99%) to* S. costicola *(ATCC 33508). NS01 infects SA39 and not SA50 while CW02 infects SA50 but not SA39. The bacteriophages were concentrated and treated with proteinase K, and DNA extraction was completed by phenol-*

chloroform followed by ethanol precipitation. Bacteriophage nucleic acid was digested by DNase, RNase, and Shrimp DNase and then compared by a gel electrophoresis assay. Restriction endonuclease digests with EcoRI and HindIII were used to compare the nucleic acid sequences of both genomes. The NS01 and CW02 genomes were found to be degraded only by DNase and Shrimp DNase, indicating that they are both double stranded DNA bacteriophages. The EcoRI digest produced unique and distinctly different fragment and banding patterns for NS01 and for CW02. The HindIII digest also produced distinctly different banding patterns for NS01 and CW02. NS01's genomic size was estimated to be 59K bp and CW02's genomic size was estimated to be 42K bp. Restriction patterns and genome size differences suggest they are unique bacteriophages. Additional specific genomic analysis is needed to determine the relationship between NS01 and CW02. Further, their respective hosts, SA39 and SA50, appear to be identical by 16S rRNA sequencing. Although it is not unusual for bacteriophages to be strain specific, this work represents the first confirmation of bacteriophage typing within S. costicola.

Introduction

The Great Salt Lake (GSL) is a hypersaline environment inhabited by a variety of halophilic microorganisms (Baxter et al. 2005). Bacteria play a significant role in nature as decomposers and in nutrient cycling and play a similar role in the GSL (Oren 2002). Bacteriophages are viruses that infect, replicate in, and kill the host bacterial cell. Bacteriophage predation on bacteria has the potential to moderate bacterial populations; however, their impact in a hypersaline environment is not well studied (Dyall-Smith et al. 2005).

Salinivibrio costicola was initially isolated from brines and salterns and characterized by Garcia et al. in 1987. It was originally classified as *Vibrio costicola* (Mellado et al. 1996). There are only two reported bacteriophages that prey upon S. *costicola*. One of them, named G3, was isolated from a salt pond near Lake Chaplin, Canada (Kauri et al. 1991). The other is named UTAK and was isolated from a saltern in Alicante, Spain (Goel et al. 1996). Both G3 and UTAK are known to be icosahedral-shaped and have tails, but little other characterization has been done (Ventosa et al. 1998).

In 2007 and 2008, *S. costicola* was isolated from the GSL, where it was found to be susceptible to predation by two bacteriophages named NS01 and CW02 (Savage et al. 2009). Some chemical and physiological characterizations of these two bacteriophages have been

completed, but the genomes were not analyzed (Savage et al. 2009). In this study, we set out to determine the structure and genetic makeup of NS01 and CW02. In doing so, we hoped to establish their molecular traits and determine whether they are variations of the same bacteriophage or independent species. It is hoped that this work would allow for future work to determine whether NS01 and CW02 share characteristics with G3 or UTAK. This information would be useful in aiding future studies as to the role of halophilic bacteriophages in nutrient cycling in hypersaline environments.

Materials and Methods

Propagation of bacteriophages

Halophilic bacteria were collected from the south arm of the GSL, and their identity was confirmed to be *S. costicola* by 16s ribosomal subunit sequencing, with strains SA39 and SA50 shown to be closely related (99%) to *S. costicola* (ATCC 33508). (Savage et al. 2009).

S. costicola strains were each grown in halophilic broth (80 g NaCl, 10 g $MgSO_4$ $7H_2O$, 5 g casein hydrolysate, 5 g KCl, 3 g disodium citrate, 1 g KNO_3, 1 g yeast extract, 0.2 g $CaCl_2$ per L) in which the NaCl concentration was altered from the original 27% to 8% (Atlas 1993). Two strains of *S. costicola* (SA39 and SA50) were used to propagate NS01 and CW02, respectfully, for this study. Bacteriophages were propagated by inoculating 1×10^9 bacteriophage into 100 mL of log phase host bacterial culture at room temperature on a rocker until clearing was observed (approximately 18 h).

Genetic material isolation methods

The genetic material of each bacteriophage was isolated by following an established protocol for isolating Lambda bacteriophage DNA (Sambrook 1982). Chloroform (1%) was added to lyse remaining bacterial cells in the *S. costicola*/bacteriophage mixture listed above. DNase (1 µg/mL) (Sigma Aldrich Corp., St. Louis, MO) and RNase (1 µg/mL) (Sigma Aldrich Corp.) were then added, and the mixture was incubated for 30 minutes. This was done to degrade bacterial host DNA and RNA. Since the culture already contained 8% NaCl, no additional salt was added, although the original protocol instructs to add NaCl at this point. The host cellular debris was removed by centrifugation at 10,000*g* for 10 minutes, after which PEG-8000 (Sigma Aldrich Corp.) was added to the supernatant, and the mixture was cooled to 4°C. The PEG 8000/supernatant mixture was then centrifuged for 10 min at 11,000*g* to precipitate the bacteriophage particles from the su-

pernatant. The aqueous phase that contained the bacteriophage particles was recovered and then centrifuged at 25,000g (4°C) for 2 hours to pellet out the bacteriophage particles. The pellet was suspended in SM buffer (5.8 g NaCl, 2 g MgSO$_4$ 7H$_2$O, 50 ml 1M Tris [pH 7.5], 5 ml 2% gelatin per liter of distilled water) and treated with Proteinase K (Sigma Aldrich Corp.) and sodium dodecyl sulfate (SDS) (Sigma Aldrich Corp.) to remove the capsid. The DNA was extracted through Phenol/Tris–Cl, then a 50/50 mixture of phenol/chloroform, and then pure chloroform. The DNA was precipitated in ice-cold ethanol and then resusupended in TE (Tris-EDTA) buffer.

The preparation of the CW02 bacteriophage followed the same method used to prepare the NS01 with a few exceptions. CW02 was grown in broth containing *S. costicola* until clearing was observed. Cellular debris was removed from the original host culture by centrifugation at 11,000g for 10 minutes. The supernatant was filtered through a 0.2-μm filter to produce a cell-free filtrate. The filtrate was then concentrated using the Amicon Centricon 100-kD MWCO filter (Millipore Corp., Billerica, MA). The bacteriophage concentrate was treated with DNase and RNase as above, centrifuged at 25,000g (4°C) for 2 hours, and then treated with Proteinase K and SDS as above. From this point forward, the CW02 DNA was extracted in the same manner as NS01.

Genomic analysis

To determine whether the two bacteriophages were DNA or RNA bacteriophages, their genetic material was treated with DNase and RNase. The resulting fragments were then analyzed by agarose gel electrophoresis. Lambda bacteriophage (a known DNA bacteriophage) was run on the same gel as a control. Each genome was also digested with Shrimp DNase, an endonuclease with a high specificity for double-stranded DNA that cleaves phosphodiester linkages to yield di- and oligonucleotides (USB Affymetrix, Santa Clara, CA). The resulting digests were assayed on an agarose gel electrophoresis and analyzed.

Restriction endonuclease digests

Both bacteriophages were treated with two restriction endonucleases EcoRI (Sigma Aldrich Corp.) and HindIII (Fisher Scientific, Fair Lawn, NJ), which cut DNA at specific sequences. EcoRI recognizes the six-nitrogenous-base sequence GAATTC, and HindIII recognizes the sequence AAGCTT. The resulting fragments were run on a 0.8% agarose gel in TBE (Tris-borate EDTA) buffer at 65 V for 4 hours. The banding pattern for each bacteriophage was then analyzed to see how the restriction digest cut each genome. The digested fragments were

run on the 0.8% agarose gel alongside a Lambda HindIII digest ladder, which was used to generate a standard curve used to elucidate genomic size.

Results

The genetic material of NS01 and CW02 was completely degraded by DNase (Fig. 1, lanes 3 and 7). The NS01 and CW02 were not digested by RNase, as seen in lanes 4 and 8. White fluorescence in a lane indicates that the genetic material was unchanged. This would be seen if the lane was not treated and served as a control, as is seen in lanes 2 and 6. The white fluorescence would also be observed if the enzyme failed to degrade the genetic material in that lane, as is seen in lanes 4 and 8. It is important to note that Lambda bacteriophage DNA genome (control) was degraded by DNase, verifying the activity of the enzymes used in this assay.
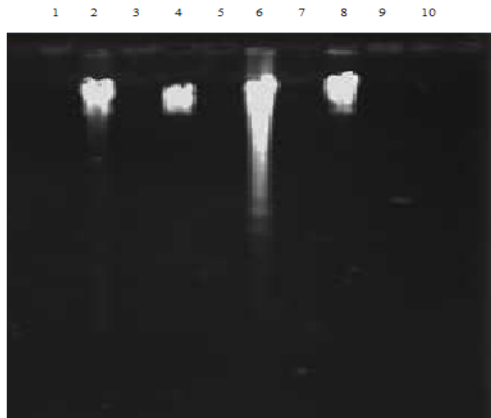
Fig. 1. DNase and RNase digest of NS01 and CW02 with Lambda DNA control. White indicates undigested DNA. Empty lanes indicate complete digestion by enzymes. The enzymes used are DNase and RNase. The presence of too much DNA sample affected the motility in some lanes and created an anomalous artifact in the gel that can be seen as streaking in lanes 2, 4, 6, and 8. (Lane 1) Lambda bacteriophage DNA + DNase; (lane 2) untreated NS01; (lane 3) NS01+ DNase; (lane 4) NS01 + RNase; (lane 5) empty; (lane 6) untreated CW02; (lane 7) CW02 + DNase; (lane 8) CW02 + RNase; (lanes 9,10) empty.

The bacteriophage genomes were treated with Shrimp DNase to determine whether they were double- or single-stranded DNA bacterio-

phages. The treated genomes of NS01 and CW02 were similarly di-
gested (Fig. 2, lanes 8 and 12. The untreated Lambda bacteriophage
genome served as a control and was not digested as is seen in lanes 7
and 11. Untreated Lambda DNA was used to demonstrate the differ-
ence in digestion of double-stranded DNA genomes when treated with
Shrimp DNase (Fig. 2, lanes 3, 7, and 11).
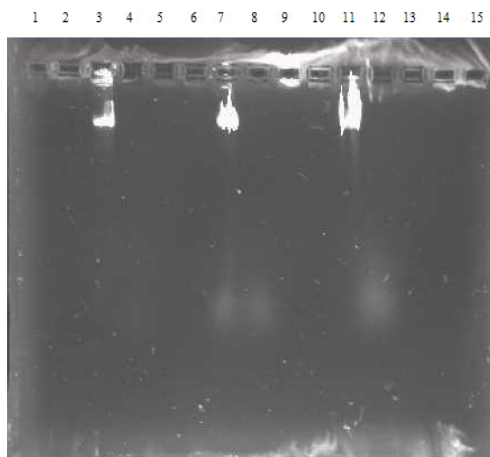
Fig. 2. Shrimp DNase digest of NS01 and CW02 with Lambda DNA control.
This gel contains DNA from the bacteriophages NS01 and CW02 with some
lanes mixed with Shrimp DNase. Shrimp DNase specifically cuts double-
stranded DNA. Empty lanes indicate digestion as noted. Lanes 3, 7, and 11
contained too much DNA sample, leading to their anomalous streaking pattern.
(Lanes 1-2) Empty; (lane 3) untreated Lambda DNA; (lane 4) Lambda +
Shrimp DNase; (lanes 5,6) empty; (lane 7) untreated NS01; (lane 8) NS01 +
Shrimp DNase; (lanes 9,10) empty; (lane 11) untreated CW02; (lane 12) CW02
+ Shrimp DNase; lanes 13-15) empty.

Restriction enzymes EcoRI and HindIII were used to observe the
sequence differences between NS01, CW02, and the control, Lambda
bacteriophage (Fig. 3). EcoRI cut the NS01 genome into 13 distinct
fragments and the CW02 genome into two distinct fragments. The
HindIII digest produced 15 distinct bands when digesting NS01 and
17 fragments when digesting CW02. The different banding patterns
between the two bacteriophages when cut with HindIII is most clearly

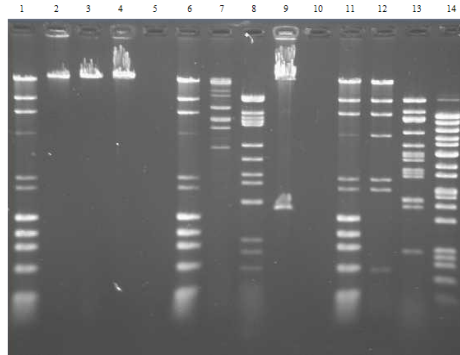**Fig. 3.** The restriction digests of NS01 and CW02 along with Lambda bacteriophage DNA (control), using the restriction enzymes EcoRI and HindIII. The DNA from the bacteriophages NS01 and CW02 were treated with restriction enzymes EcoRI and HindIII to show unique banding patterns. Lamda bacteriophage was used on this gel as a control and DNA ladder to allow us to quantify the size of the DNA fragments for each of the bacteriophages. (Lane 1) Lambda + HindIII DNA ladder; (lane 2) untreated Lambda DNA; (lane 3) untreated NS01; (lane 4) untreated CW02; (lane 5) empty; (lane 6) Lambda + HindIII ladder; (lane 7) Lambda DNA + EcoRI; (lane 8) NS01 + EcoRI; (lane 9) CW02 + EcoRI; (lane 10) empty; (lane 11) Lambda + HindIII ladder; (lane 12) Lambda DNA + HindIII; (lane 13) NS01 + HindIII; (lane 14) CW02 + HindIII. This gel gives the best visual pattern of differences between the genomes of NS01 and CW02. Additional gels were run to resolve bands that ran too close together to allow proper resolution.

pronounced in the region of the gel that includes 2500–1000 DNA base pairs (bp). This region shows two bands for NS01 and five bands for CW02. The size of the genome was determined by adding up the individual fragments cut by restriction enzymes and estimating their size based on their migration on the agarose gel. A ladder was used to aid in the size determination of the fragments. The ladder chosen for this experiment was Lambda bacteriophage cut with the restriction enzyme HindIII. The NS01 fragments were estimated to be 59K bp of DNA, whereas the CW02 fragments were estimated to be of 42K bp.

Discussion

The complete degradation of CW02 and NS01 bacteriophages when treated with DNase confirmed that both are DNA bacteriophages. This was further supported by the results that RNase failed to show any signs of cutting the two bacteriophages genomes. The lack of any

bands seen when the two bacteriophages were treated with the Shrimp DNase, an enzyme known only to cut double-stranded DNA, indicated that both NS01 and CW02 are double-stranded DNA bacteriophages.

The large discrepancy in the banding patterns seen in the digests performed with EcoRI and HindIII is good evidence that NS01 and CW02 are different bacteriophages that are probably not closely related. If the two bacteriophages are very closely related, they would have had very similar genomes. In two closely related genomes, upon treatment with restriction endonucleases, one would expect two very similar banding patterns on an agarose gel. This was not observed with these two bacteriophages. When they were both cut with EcoRI, the NS01 genome produced six times as many fragments as CW02, which was only cut once. A difference in banding patterns was also seen when the two bacteriophages were cut with HindIII. In the 2500–1000 bp region, the NS01 genome shows two fragments and the CW02 genome shows five. That fact that the sizes of the two genomes differ by more than 15K bp is further evidence that the two bacteriophages are not closely related. In comparison to other bacteriophages that are known to infect *S. costicola,* there is no report on the characterization of the genetic material of G3; however, UTAK is reported to be 80K bp in length, which is considerably larger than NS01 or CW02.

We successfully characterized two bacteriophages that are composed of DNA but contain markedly different genome structures. While there were distinct differences in the genomic sizes and sequences, it is possible that there are similar genetic elements or gene arrangements. This can only be determined by sequencing and annotating of their respective genomes. Furthermore, their respective hosts, SA39 and SA50, appear to be identical by 16S rRNA sequencing. Although it is not unusual for bacteriophages to be strain specific, this experiment represents the first example of two bacteriophages demonstrating strain preference within *S. costicola*.

Acknowledgments

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Characterization of Marinobacter Bacteriophage TS22 Isolated from the Great Salt Lake, Utah

Thomas B. Simon, Craig J. Oberg,
Michele D. Culumber, and Matthew J. Domek
Weber State University

Abstract

Two euryhalophilic bacteria, Marinobacter *SA51 and SA52, were isolated from the Great Salt Lake (GSL) South Arm. The* Marinobacter *genus, a γ-Proteobacteria, has been isolated from marine environments but hasn't been previously reported in the GSL. A halophilic phage, TS22, that only infects* Marinobacter *SA51 was then isolated from GSL water. TS22 formed 4- to 5-mm-diameter plaques on SA51 in 0.8% soft agar. A one-step growth curve showed a replication time of 40 minutes, an eclipse period of 10 minutes, and a burst size of 65. The effect of NaCl, MgSO$_4$, and KCl salt concentrations on TS22 attachment and infection was tested. The phage was incubated with SA51 in a solution of 0%, 6%, or 12% of each salt for 10 minutes. Cells were then diluted and plated in soft agar overlays, and plaque-forming units/ml were calculated. Attachment was greatest at 6% NaCl. When NaCl was replaced with either MgSO$_4$ or KCl (6% w/v) during attachment, a 10-*

fold and 100-fold decrease in plaque number was observed, respectively. In the absence of salt, plaque formation decreased 1000-fold. It appears that salt type and concentration influences phage infection in Marinobacter, *perhaps because of changes in charge density of the surfaces or receptor sites, which alter attachment. This finding suggests how seasonal and climatic events could alter phage–host interactions, thus impacting recycling of microbial biomass in the lake.*

Introduction

The Great Salt Lake's (GSL) South Arm is a hypersaline environment that supports the growth of euryhalophilic bacteria (Baxter et al. 2005). Weimer et al. (2009) used data generated with the Affymetrix phylochip to estimate GSL microbial diversity at over 1,000 different genera in 31 families. Euryhalophilic bacteria make an important contribution to the ecological balance in the GSL since they generally form the base of the food web and act as decomposers to facilitate nutrient recycling (Dyall-Smith et al. 2005). These organisms represent a significant portion of the GSL biomass (Parnell et al. 2011) and can reach high concentrations during certain seasons of the year when the concentration of nutrients is high and there is wind-generated aeration (Ventosa 2006).

Marinobacter is a genus of euryhaline *γ-Proteobacteria* that primarily inhabits pelagic and benthic marine environments. *Marinobacter* species have also been isolated from petroleum-field brines, coastal hot springs, hydrothermal vent plumes, saline soils, volcanic basalts, surface seawater, deep seawater, and marine snow (Singer et al. 2011). Members of this genus are facultatively anaerobic or strictly aerobic heterotrophs. Some species can grow via hydrocarbon degradation, while others reduce arsenate, oxidize arsenite, and even reduce perchlorate (Gauthier et al. 1992; Handley et al. 2009; Van Ginkel et al. 2010).

Bacteriophages (phages) are viruses that infect bacteria and may be a significant source of bacterial mortality in hypersaline environments (Kauri et al. 1991; Dyall-Smith et al. 2005). Phages play an important role in recycling nutrient biomass in their environment (Suttle 2007; Rodriguez-Brito et al. 2010). Phages can also mediate transduction, lysogenic conversion, and species successions and help maintain microbial diversity (Jiang et al. 2004). While phage predation of bacteria may be a significant source of mortality in hypersaline environments (Dyall-Smith et al. 2005), there are very limited reports of phage predation in the GSL (Kauri et al. 1991). One reason for this may be

the lack of well-characterized phage–host model systems expressly isolated from the GSL.

There have been no reports of *Marinobacter* being isolated from the GSL nor of phages that infect *Marinobacter* isolated or identified in the GSL. In this study, we sought to determine whether GSL-isolated *Marinobacter* strains are susceptible to phage predation from phage present in the GSL and to characterize the resulting phage isolates.

Materials and Methods

Halophilic medium

Halophilic broth (HB) was used to isolate microorganisms from the GSL. HB contains, per L of distilled water, 80 g of NaCl, 12.5 g of MgSO$_4$, 2.5 g of casamino acids, 2.5 g of yeast extract, 1.25 g of protease peptone, 1.5 g of trisodium citrate, and 0.1 g of sodium acetate. Medium was adjusted to pH 7.2 with 1N NaOH prior to sterilization. HB agar (HBA) included 15 g agar per L while HB soft agar (HBSA) had 8 g agar added per L.

Microscopy

Overnight cultures of SA51, grown in HB, were observed as wet mounts on an Olympus BX-41 phase-contrast microscope. The cells were viewed and photographed at 400× and 1000× magnification.

Halophile isolation and 16S rRNA gene sequencing

Sediment and water were collected from the South Arm of the GSL. Water samples were taken 20 cm below the water surface, and sediment from the top 10 cm was collected in water 0.5 m deep. Samples were inoculated on HBA plates and incubated at 30°C for 2 wks. As colonies appeared, they were transferred to HB and confirmed as pure cultures using quadrant streaks on HBA prior to DNA isolation.

DNA from isolates was extracted using the UltraClean Microbial DNA Extraction Kit (MO BIO Laboratory, Carlsbad, CA). The 16S rRNA gene was amplified using bacteria specific primers (27F 5' AGA GTT TGA TCM TGG CTC AG 3'/1492R 5' ACG GYT ACC TTG TTA CGA CTT 3') (Lane 1991). The reaction mixture contained 200 nM of each primer, 250 µm of the dNTPs, 0.2 mg/ml bovine serum albumin, 1U DNA Taq Polymerase, and the diluted reaction buffer (Promega Corp., Madison, WI). The amplification parameters were 94°C for 3 min, followed by 25 cycles of 94°C for 45 sec, 57°C for 1 min, 72°C for 2 min, and a final extension step at 72°C for 7 min.

DNA was sequenced at the Idaho State University Molecular Research Core Facility, Pocatello, ID. Approximately 1300 bp of each isolate's 16S rRNA gene was compared with the GenBank database using BLAST and aligned to sequences in the Ribosomal Database Project (RDP) database (http://rdp.cme.msu.edu/). Sequences from a selection of similar organisms were used to recreate a neighbor-joining phyloge-netic tree using the Jukes-Cantor correction model. Phylogenetic analysis was done using the MEGA5 program.

Determination of optimal salt concentration for Marinobacter SA51

An 18-hr culture of *Marinobacter* SA51 (grown at $30°C$ in HB) was inoculated in triplicate into 6 ml of HB containing either 0%, 4%, 8%, or 12% w/v NaCl and incubated for 5 d at $30°C$. Absorbance (OD_{600} nm) was measured using a Spec 20 spectrophotometer.

Phage enrichment and isolation of TS22

Water samples from the South Arm of the GSL were centrifuged at 3000*g* for 15 min and filtered through a sterile 0.45-µm filter (250-ml Filter System, Corning Inc., Corning, NY). One hundred milliliters of HB broth, 8 ml of the GSL filtrate, and 5 ml of an 18-hr culture of either *Marinobacter* SA51 or SA52 were combined in a 250-ml flask and incubated at $22°C$ for 72 hr on a shaker. Phage enrichments were centrifuged at 3000*g* for 10 min and then filtered through a 0.45-µm sterile syringe filter (Corning Inc.).

To isolate unique phages, a plaque assay was done by mixing 0.5 ml of the enrichment filtrate with 0.5 ml of an 18-hr culture of host (either SA51 or SA52) in 4 ml of 0.8% soft agar. This was poured over HBA and allowed to incubate for 24 h at $30°C$. Agar plugs were re-moved from the center of suspected plaques using a sterile Pasteur pi-pette. The plugs were transferred to 1 ml of sterile 8% NaCl, mixed in a vortex mixer, and incubated for 1 hr at $25°C$. After 1 hr, the plugs and saline were filtered through a 0.45-µm sterile syringe filter. No plaques were observed using SA52 as the host in phage enrichments. A soft agar overlay was made with 0.5 ml of an 18-hr culture of SA51, and then 5 µl of filtrate was spotted on the host lawn to confirm whether a phage had been isolated. One phage isolate, TS22, was selected for further study.

Streak tests of TS22 against potential host strains

TS22 was tested against host strain SA51, SA52, and several *Salinivibrio* and *Idiomarina* isolates using the streak assay. Eighteen hour cultures (incubated at 30°C in HB) of potential hosts were diluted 1:10 in sterile 8% NaCl. Halophilic medium agar plates were prepared by applying four streaks of the diluted host bacteria across the length of the agar, one streak for each host isolate. A 2-μL droplet of a purified phage isolate was applied to the center of each streak. Petri plates were incubated at 30°C for 24 hr.

One-step growth curve

A one-step growth curve was generated to characterize a single cycle of phage replication for TS22. TS22 (0.1 ml) was allowed to ad-sorb into *Marinobacter* SA51 (0.9 ml) for 5 min at 30°C in a sterile 1.5-ml microfuge tube, after which the infected bacteria were harvested by centrifugation for 1 min at 12,000g. The pellet was resuspended and diluted in sterile 8% NaCl (pH 7.2) to prevent further phage attach-ment. From this dilution, samples were taken at 1-, 2-, 5-, 10-, 20-, 30-, 40-, and 50-minute intervals and titered using the plaque assay. Plaques at each time point were quantified and used to determine the replication time and burst size of TS22. The one-step growth curve was done in triplicate.

Effect of NaCl, MgSO₄, and KCl on attachment of TS22

Ten microliters of the phage TS22 was incubated with 10 μl of an overnight culture of SA51 in a solution of 0%, 6%, or 12% of each salt for 10 min. Cells were then centrifuged at 12,000g for 1 min, and each pellet was washed with the respective salt solution three times. Upon completion of the wash cycle, cells were diluted and plaque-forming units (PFUs)/ml were determined using the soft-agar plaque assay. The same procedure was repeated with sterile filtered GSL water, and the results were compared.

Characterization of TS22 nucleic acids

Nucleic acids (NAs) were extracted from three preparations of pu-rified TS22 using the NORGEN Phage DNA Isolation Kit (Thorold, Ontario, Canada). The first was 75 ml of concentrated phage prepara-tions with a titer of approximately 10^9 PFU/ml. This sample had been stored frozen for approximately one year. The second sample was 1 ml of the same phage sample, prior to concentration. The third sample

was phage TS22 that had been amplified in the host and purified two weeks prior to NA extraction. Two extractions were done for each sample. The phage preparations were treated with 20 U DNase (Sigma) prior to NA isolation to remove any contaminating host DNA. After extraction, the phage NA was immediately run on a 1% agarose gel for 30 min at 80 V and visualized under ultraviolet light after staining with ethidium bromide.

Results and Discussion

Isolation of Marinobacter *SA51*

Based on comparisons of their 16S rRNA sequences, isolates SA51 and SA52 are clustered in the genus *Marinobacter* (Fig. 1). Phylogenetic and BLAST analysis indicate that SA51 and SA52 share 96% sequence identity over approximately 1300 bp of the 16S rRNA gene. Each sequence is 99% similar to the nearest relative.

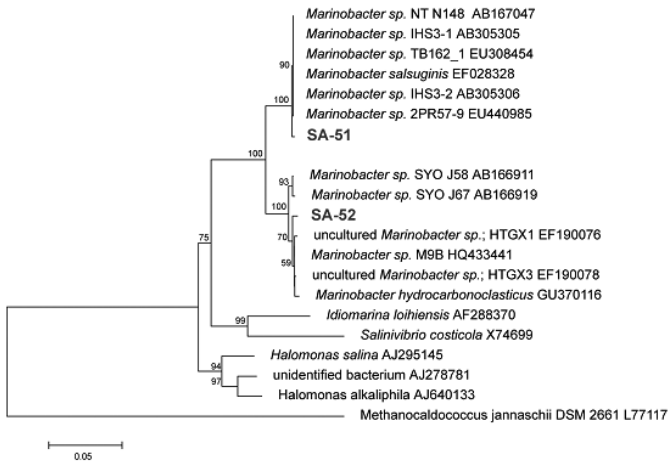**Fig. 1.** Phylogenetic tree for *Marinobacter* SA51 and SA52 isolated from the Great Salt Lake. Tree nodes with greater than 50% bootstrap replicates are indicated on the tree (100 bootstrap replicates were performed).

Since no phage was isolated for SA52, the remainder of this research focused on the characterization of SA51. Phase-contrast images of SA51 wet mounts exhibited motile rod-shaped cell morphology

characteristic of this genus (Fig. 2). SA51 stained gram-positive. Growth for SA51 was optimal at 4–8% NaCl with minimal growth observed at 0% NaCl, characteristic of a euryhalophile (Fig. 3).
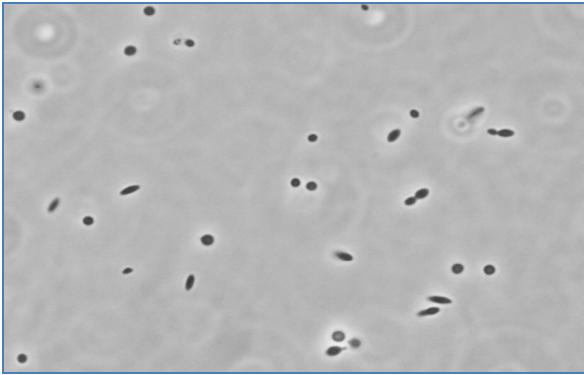
Fig. 2. Phase-contrast image of SA51 (1000×). SA51 is a motile bacillus. Some cells were club-shaped, and cell arrangement was as single or diplobacilli.
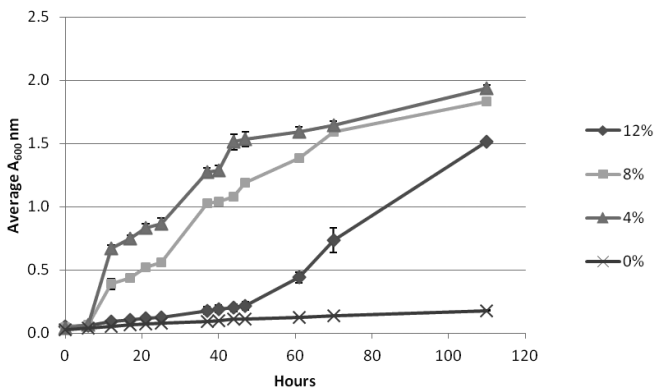
Fig. 3. Growth of *Marinobacter* SA51 at different NaCl concentrations. An 18-hr culture of *Marinobacter* SA51 was used to inoculate, in triplicate, 6 ml of HB containing 0%, 4%, 8%, or 12% w/v NaCl and incubated for 5 d at 30°C. Absorbance (OD_{600} nm) was measured using a Spec 20 spectrophotometer. Error bars indicate one standard deviation.

Isolation of Marinobacter *bacteriophage TS22*

Using a bacteriophage enrichment technique, a phage (TS22) that infects SA51 was isolated from the South Arm of the GSL (Fig. 4). Plaques of TS22 varied in size from 2 to 5 mm and appeared after 48 hr at 30°C (Fig. 4A). Although plaque size varied on the original isolation plates, repurification of individual plaques resulted in consistent plaque sizes (Fig. 4B). Plaque size variation could be due to the growth phase of host cells at the time of infection or to the ionic strength of the medium (Kukkaro and Bamford 2009). Streak tests confirmed that TS22 does not infect *Marinobacter* SA52, *Idiomarina,* or *Salinivibrio* previously isolated from the GSL. Phages that infect these genera do not infect SA51 (data not shown).
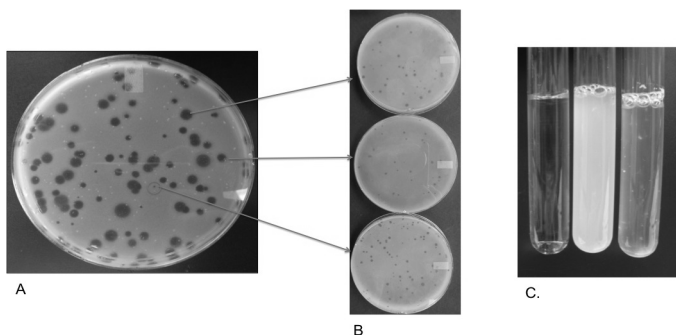

Fig. 4. A. Plaque morphology for TS22 on *Marinobacter* SA51. **B.** Secondary isolation of large (top petri plate), medium (middle petri plate), and small (bottom petri plate) plaques. **C.** SA51 broth cultures demonstrating clearing caused by phage infection: Left Tube, uninoculated HB; center tube, non-TS22 infected SA51; right tube, SA51 infected with TS22.

One-step growth curve

In the one-step growth curve, the latent period is the time from phage DNA injection to the release of mature phage, and the burst size is the average number of mature phage particles released by lysis of a single cell. Burst size is calculated by dividing the phage concentration at the end of the growth cycle by the initial concentration. Results showed TS22 produced a burst size of 65 PFUs per bacterial cell and that the phage replication cycle took 40 min with a latent period of 10 min (Fig. 5).
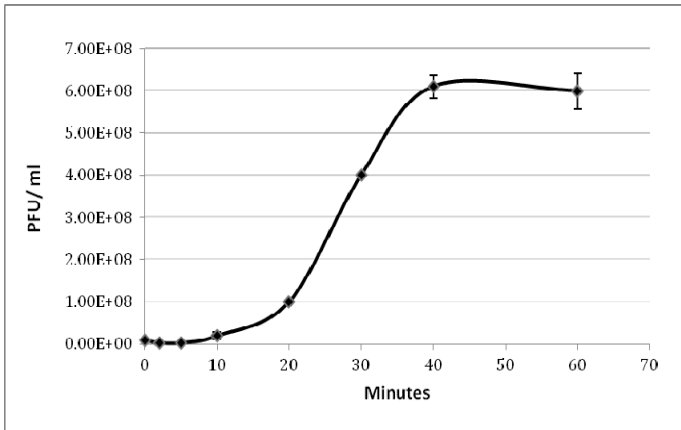
Fig. 5. One-step growth curve for phage TS22. TS22 (0.1 ml) was allowed to attach to *Marinobacter* SA51 (0.9 ml) for 5 min at 30°C in a sterile 1.5-ml microfuge tube, after which the infected bacteria were harvested by centrifugation for 1 min at 10,000 rpm. The pellet was resuspended and diluted in sterile 8% NaCl (pH 7.2) to prevent further phage attachment. From this dilution, samples were taken at 1-, 2-, 5-, 10-, 20-, 30-, 40-, and 50-minute intervals and titered using the soft agar plaque assay. Error bars indicate one standard deviation.

Phage attachment at various salt concentrations

Phage attachment was greatest in a solution of 6% NaCl. When NaCl was replaced with either $MgSO_4$ or KCL at 6% w/v concentration during the attachment period, a 10-fold and 100-fold decrease in plaque number was observed, respectively. In the absence of any salt using only sterile distilled water, plaque formation decreased 1000-fold (Fig. 6). Phage attachment in the sterile filtered GSL water was most similar to the attachment seen in the incubation with 6% NaCl, even though the NaCl concentration was much higher (approximately 10%), suggesting that other factors in the environment may play a role in phage attachment.

Characterization of TS22 nucleic acids

Phage NA was recovered from each of the preparations. Concentrating the phage greatly improved the quantity recovered. Unlike DNA preparations from *Salinivibrio* and *Idiomarina* phage, TS22 has three distinct bands and some small sheered or fragmented pieces (Fig.
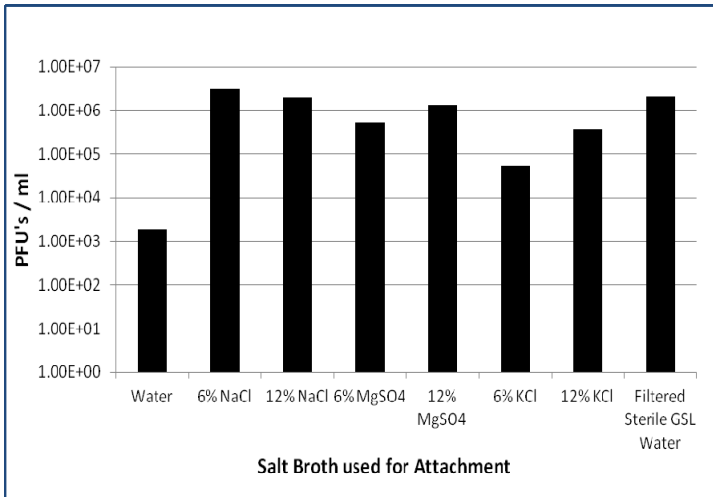
Fig. 6. TS22 phage attachment using various salts and salt concentrations. Ten microliters of the phage TS22 was incubated with 10 μl of an overnight culture of SA51 in a solution of 0%, 6%, or 12% of each salt for 10 min. Cells were then centrifuged at 12,000*g* for 1 min, and each pellet was washed with the respective salt solution three times. PFUs/ml were determined using the soft-agar plaque assay. The same procedure was repeated with sterile filtered GSL water, and the results were compared.

7). In previous experiments, the main bands degrade over time while stored in the freezer. This has led us to suspect the genome of TS22 may be either segmented RNA or fragmented ssDNA. To confirm that the genome is segmented and not fragmented because of the age of the sample, we tested new and old preparations of the bacteriophage NA. The gel results (Fig. 7) showed three bands that were consistent in size, indicating a segmented genome rather fragmented NA due to degradation. It is difficult to estimate the molecular weight size, but it is in the range of molecular weights found in the HindIII digest of Lambda bacteriophage (<21,000 bp but >2000 bp).

Fig. 7. Agarose gel electrophoresis of NA extractions from TS22. Lane 1, Lambda phage DNA HindIII digest; lane 2, TS22 Prep 1 concentrated frozen phage NA; lane 3, TS22 Prep 2 frozen, nonconcentrated phage NA; lane 4, TS22 Prep 3 freshly harvested, non-frozen, phage NA; lanes 5–7, same as lanes 2–4, second extraction; lane 8, Lambda phage DNA HindIII digest.

Conclusions

Marinobacter-like bacteria have not previously been reported in the GSL (Baxter et al. 2005). We initially isolated two members of this genus from the GSL South Arm. 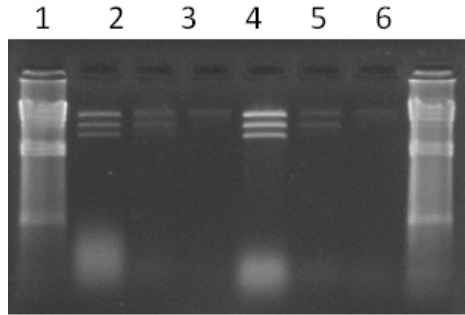One isolate, SA51, was selected for further study. SA51 has a wide salt tolerance exhibiting growth from 4–12% NaCl with optimum growth at 4–8% NaCl, consistent with the salt concentrations in the GSL South Arm. Since South Arm salinity varies seasonally, a wide salt tolerance would enable this organism to survive in the changing environment. Organisms from the *Marinobacter* clade are commonly found in moderately saline environments, where they can account for a large proportion of the microbial community (Singer et al. 2011). Some species of *Marinobacter* are capable of hydrocarbon degradation (Gauthier et al. 1992), and the GSL contains numerous natural oil seeps that could supply *Marinobacter* with these nutrients. The metabolic capabilities of SA51 should be characterized, as it could be useful for bioremediation of moderately halophilic ecosystems contaminated with hydrocarbons.

We believe this organism has not been isolated previously because it requires a lower nutrient medium and longer incubation time for initial colonies to appear. Quickly growing organisms (e.g., *Salinivibrio* and *Idiomarina*) may outcompete *Marinobacter* on high-nutrient media. Using oligotrophic media and extended incubation strategies allowed isolation of organisms not previously identified in the GSL.

Phage TS22 replicates quickly (40 min) with mature phage particles produced after 10 min. TS22 showed a relatively small burst size (65 PFUs). NS01, a phage that infects a *Salinivibrio costicola* strain isolated from the GSL, showed a burst size of 100 PFUs (Savage et al. 2009). More work is needed to understand the significance of this burst size range with regards to impact on modulation of bacterial populations. The genome of TS22 shows three distinct bands following NA extraction. These do not appear to be due to enzymatic degradation. Instead, we hypothesize that the TS22 genome consists of either RNA or single-stranded DNA. This is different from the genomes of other halophages isolated from the GSL that have single, circular DNA genomes.

Bacteriophages, such as TS22, are likely important for controlling the population size of halophilic microorganisms in the GSL (Rodriguez-Brito et al. 2010). Other than brine shrimp, GSL micro-organisms have few predators, so phages may play a significant role in recycling nutrients stored in the microbial biomass. Our experiments demonstrate that SA51 can be infected by a phage that has stringent host specificity. In the laboratory, it only infects *Marinobacter* strain SA51 and not a closely related isolate, SA52. This could indicate that TS22 phage is only involved with controlling the population density of SA51, suggesting a very tight control mechanism; however, it is also possible that SA52 is resistant to bacteriophage infection (Singer et al. 2011).

Further experiments are needed to determine whether TS22 infects SA51 under the environmental conditions of the lake; however, it appears that the type and concentration of salts influences phage infection in *Marinobacter*, perhaps because of changes in charge density of the cell surface or receptor sites, which would alter attachment of the phage to the host. This could explain how seasonal and climatic events, such as flooding and drought, could alter the phage–host interactions, thus impacting the recycling of microbial biomass in the GSL.

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Personality and Competitive Antecedents of Sales Performance: Surprising Findings

Adam Webb, Spencer Petty, Jarrod Heiner, Jorge Marimontes, and Paul Dishman
Utah Valley University

Abstract

In this study, individual personality and competitiveness traits were assessed as predictors of personal sales performance. Need for Achievement, Need for Power, Need for Affiliation, Interpersonal Competitiveness, and Goal Competitiveness were measured in sales representatives from three different companies within the multilevel marketing industry. Participants were broken into high and low performance groups, and scores were correlated with each group. Results indicated that: (a) Interpersonal Competitiveness strongly correlates with sales performance within the multilevel marketing industry; (b) certain personality and competitiveness constructs expected to correlate yielded surprising results. Limitations to the study include data type and an uneven gender sampling. The research accomplishes three objectives: (a) to study predictive performance traits in the fairly untested multilevel marketing industry; (b) to establish whether traits

predict performance differently in multilevel marketing than in other sales industries; and (c) to identify a simple and effective questionnaire to assist recruiters in predicting the performance of potential new hires within the multilevel marketing industry.

1. Introduction

Since the late 1930s, a slew of scholarly research has all similarly revealed that certain personality traits correlate positively with individual sales performance. This specific niche of study holds significant managerial relevance for firms, as screening out applicants lacking predictive personality traits saves companies considerable time and money. When it comes to predicting general workplace performance, the measuring of personality traits in the application process is a common practice today, utilized by industry giants such as Walmart and Federated (owner of Macy's and Bloomingdale's).

One of the earliest of these types of studies was conducted 75 years ago, in which the individual performance of 75 department store associates was correlated with one personality construct, "social dominance."[1] Since that time, researchers have identified a myriad of other personality traits that correlate with individual performance, including but not limited to, sociability and self-confidence,[2] self-esteem,[3] type A behavior,[4] sensation seeking,[5] conscientiousness,[6] attributional style,[7] achievement striving,[8] and extraversion.[9]

More recently, however, researchers have begun testing traits of competitiveness to determine correlation to personal sales performance. In 1998, Brown et al. found that salespeople measuring high in trait competitiveness would predictably set and achieve higher sales goals when placed in a competitive work environment.[10]

While previous research has clearly drawn a connection between personality/competitiveness traits and sales performance, the body of research fails to adequately test these constructs across all industries. Researchers typically use whatever industry is available to them to test the correlation between individual traits and performance. Very few studies, if any, have examined whether these traits will predict performance differently depending on industry or sales model. Bartkus et al. hypothesized, for example, that although Type A behavior predicted performance in a real estate brokerage (an environment where work is highly individualized), it may actually correlate negatively in other sales environments where work is more team centered.[4]

In this study, constructs of personality and competitiveness were tested for correlation with individual performance within the fairly un-

tested multilevel marketing industry. This industry employs a unique affiliate-distribution sales model that differs from traditional sales modes.

In the traditional sales model, a separation exists between the recruiting and sales process. Typically, companies' Human Resources departments are responsible for recruiting the sales force, while the sales force is responsible for selling the product. The bulk of the salesperson's compensation comes from selling the product, which is generally sold through wholesale and retail distribution.

In multilevel marketing, the recruiting and sales processes are combined. The sales force is responsible for selling the product *as well as* recruiting new salespeople, called "distributors." Salespeople are primarily compensated for recruiting and secondly for sales. Product is distributed through peer-to-peer networks of distributors who recruit and are compensated for bringing more distributors into the firm. Compensation for sales associates grows as they progress from the beginning performance tiers to the top tiers by recruiting more distributors into the firm. A "down-line" is built as a distributor's recruits bring in more recruits, who bring in more recruits (Fig. 1).
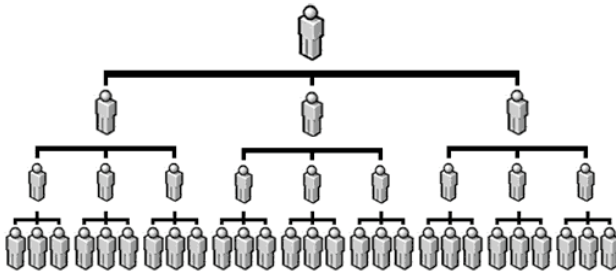
Fig. 1. Multilevel marketing model

By establishing correlations within this unique field of sales research that differs from similar studies in other industries, we hope to establish the necessity for new industry comparative research. This study hopes to address the question of whether it is necessary to categorize sales industries and retest the validity of previously correlated constructs across all industries.

Additionally, by aggregating some of the most important personality/competitiveness measures into one questionnaire, this study will produce a simple but effective tool for recruiters to use in screening sales applicants within the multilevel marketing industry.

We hypothesize that:

1. Need for Achievement (nAch) will have strong positive correlation with individual sales performance. nAch is characterized by a desire to succeed in a task that leads to personal gain.[11]
2. Need for Affiliation (nAff) will have moderate positive correlation with individual sales performance. nAff is characterized by a desire to maintain relationships and be accepted by others.[11]
3. Need for Power (nPow) will have strong positive correlation with individual sales performance. nPow is characterized by a desire to organize people toward organizational goals.[11]
4. Interpersonal Competitiveness (IC) will have moderate positive correlation with individual sales performance. IC is characterized by a desire to do better than others and to win in individual competition.[12]
5. Group Competitiveness (GC) will have strong positive correlation with individual sales performance. GC is characterized by a desire to be the best one can be.[12]

2. Limitations

This study was limited by the following factors. It is recommended that future studies be conducted in which these limitations are eliminated or reduced.

2.1. Lack of continuous data

In multilevel marketing companies, distributors are ranked into performance tiers, such as "bronze," "silver," or "gold," which cover all levels of sales performance, from new associates with no production to the top performing salespeople. For the dependent variable Sales Performance, participants were asked to indicate their performance tier. This type of data creates problems in analysis, as categorical data does not correlate as well as continuous data. For future studies, we suggest that a different metric of sales performance be measured that would produce continuous data, such as "Total units sold in down-line."

2.2. Sample size

The combined number of usable surveys from all three multilevel marketing companies was 105 (see Methodology). With performance categories broken into approximately 12 tiers, this did not leave a statistically significant sample to test in *every* category. We then had to further reduce the dependent variable Sales Performance into two

groups for high and low performance. In future studies, we recommend surveying as many participants as is necessary to achieve a statistically significant sample size in each performance category. Even with a lack of surveys for each performance tier, however, there was still enough data across the entire distribution to distill a correlation once the tiers were consolidated.

2.3. Collection of specific performance measures

To maintain an appropriately lengthed survey, the tested constructs were limited to five. In building a complete model for predicting sales performance and in validating other studies, it would be necessary to study many more applicable constructs, possibly in multiple studies.

2.4. Gender differences

Because of the higher proportion of men within each of the three company's sales forces, a significantly small sample of female participants was received. It seems that given the differences between male and female competitiveness identified in past scholarly research,[12] future studies should attempt to capture a more even gender sample. We believe, however, that this variable only slightly moderates the results and does not significantly impact the outcome.

2.5. Assumptions

We assume that participants from the three different multilevel marketing companies operate within fairly similar sales environments. In reality, it's possible that certain factors such as better management or differing geographic markets could moderate the relationship between personality/competitiveness traits and sales performance. It is assumed that the sample size is large enough that moderating variables such as these are smoothed out of the data.

3. Methodology

Personality and competitiveness constructs were selected based on a mix of two factors: (a) our opinion as to which constructs would most likely predict sales performance, and (b) identification of constructs that had not been previously tested for correlation with sales performance. McClelland's Theory of Needs, including nPow, nAch, and nAff, were selected, as well as IC and GC.[12] These constructs, along with their measures, definitions, and application to this study are outlined in Table 1.

Table 1. Personality and competitiveness constructs			
	Measure	**Definition**	**Application**
nPow	Thematic apperception test	The desire to organize people to further organizational goals	High nPow individuals often rise to sales leadership
nAff	Thematic apperception test	The desire to maintain harmonious relationships and to feel accepted by other people	High nAff individuals typically perform well when job requires client interaction and customer service
nAch	Thematic apperception test	The desire to excel in a task leading toward personal gain	High nAch individuals work well in situations where they either work alone or with other high achievers (a typical sales environment)
GC	Competitiveness questionnaire	The desire to excel, to obtain a goal, and/or to be the best one can be	High GC individuals are driven to perform on their commitments and goals
IC	Competitiveness questionnaire	The desire to do better than others, the desire and enjoyment of interpersonal competition and winning	High IC individuals are motivated by competition with others
nPow, Need for Power; nAff, Need for Affiliation; nAch, Need for Achievement; GC, Goal Competitiveness; IC, Interpersonal Competitiveness			

4. Results

Through multiple regression, a correlation was identified between sales performance and IC. IC correlated with performance rank positively at .221, with significance just below 0.5. While it was predicted that certain other traits would also correlate with sales performance, we were surprised to find that all other constructs tested bore no significant relationship to sales performance. Construct correlation scores ranged from 0.514 to 0.747. Table 2 shows all constructs and their correlations to sales.

Table 2. Multiple regression of all constructs (independent variables) to sales performance (dependent variable)

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.016	5	.203	.861	.512[a]
	Residual	17.471	74	.236		
	Total	18.487	79			

a. Predictors: (Constant), NPOWAVG, GCAVE, ICAVG, NACAVE, NAFFAVG
b. Dependent Variable: RANK

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.684	.742		.921	.360
	ICAVG	.160	.094	.217	1.692	.095
	GCAVE	.116	.177	.077	.652	.516
	NACAVE	-.022	.140	-.021	-.159	.874
	NAFFAVG	-.033	.113	-.041	-.288	.774
	NPOWAVG	.021	.106	.027	.197	.844

a. Dependent Variable: RANK

According to these regressions, our hypotheses stand as follows:

1. More Research Required. Need for Achievement (nAch) bore no significant correlation to Sales.
2. More Research Required. Need for Affiliation (nAff) bore no significant correlation to Sales.
3. More Research Required. Need for Power (nPow) bore no significant correlation to Sales.
4. Supported. Interpersonal Competitiveness (IC) bore significant correlation to Sales.

5. More Research Required. Group Competitiveness (GC) bore no significant correlation to Sales.

To determine whether IC actually predicted sales performance, linear regression was conducted. IC again bore the highest significance of all the constructs at 0.095 and also the highest t-score at 1.692. Table 3 contains the linear regression analysis showing this relationship.

Table 3. Linear regression of all constructs (independent variables) to sales performance (dependent variable)

Correlations

		RANK	NPOWAVG	NAFFAVG	NACAVE	GCAVE	ICAVG
RANK	Pearson Correlation	1	.074	-.037	.044	.057	.221*
	Sig. (2-tailed)		.514	.747	.695	.615	.049
	N	80	80	80	80	80	80
NPOWAVG	Pearson Correlation	.074	1	.920**	.919**	.748**	.502**
	Sig. (2-tailed)	.514		.000	.000	.000	.000
	N	80	105	105	105	105	105
NAFFAVG	Pearson Correlation	-.037	.920**	1	.933**	.792**	.417**
	Sig. (2-tailed)	.747	.000		.000	.000	.000
	N	80	105	105	105	105	105
NACAVE	Pearson Correlation	.044	.919**	.933**	1	.785**	.507**
	Sig. (2-tailed)	.695	.000	.000		.000	.000
	N	80	105	105	105	105	105
GCAVE	Pearson Correlation	.057	.748**	.792**	.785**	1	.586**
	Sig. (2-tailed)	.615	.000	.000	.000		.000
	N	80	105	105	105	105	105
ICAVG	Pearson Correlation	.221*	.502**	.417**	.507**	.586**	1
	Sig. (2-tailed)	.049	.000	.000	.000	.000	
	N	80	105	105	105	105	105

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

5. Discussion and Conclusion

While IC was the only construct that correlated with sales rank in this study, the authors believe that changes in the sampling process would create a better set and produce more accurate results. Particularly, the authors suggest that when this study is repeated among multi-level marketing firms continuous data from sales participants should be collected instead of categorical data. For the multilevel marketing industry, these could include: "annual earnings in dollars from multilevel marketing activities," "quantity of active down-line distributors," or "number of units sold throughout entire down-line." Different companies use different metrics of performance to establish their tiers. By asking participants to indicate their "performance tier," the authors made it difficult to aggregate data from different companies into one

sampling. The authors suggest that this study be repeated with continuous sales data and a larger sampling. They expect that researchers will identify other, possibly even unique, constructs that correlate with sales performance in this particular sales industry

Despite these limitations, however, IC still arose as correlative and predictive. This finding within the multilevel marketing industry corroborates similar studies in other industries. The authors therefore concur with former research and suggest that IC holds the highest value in predicting individual sales performance, regardless of industry.

It is recommended that managers responsible for recruiting new salespersons test applicants using the Competitiveness Questionnaire (Table 4).[12] Managers should compare IC scores of applicants with IC scores of currently employed, top-performing sales people within their firm. This will enable recruiters to assess the likelihood that a new hire will achieve similar results.

Table 4. Competitiveness questionnaire for assessing interpersonal competitiveness in applicants[12]

Please take a moment to complete ALL of the following questions. Just circle the number that best corresponds to your answer.

INTERPERSONAL COMPETITIVENESS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I perform better when I am competing against someone rather than when I am the only one striving for a goal.	1	2	3	4	5
2. I do *not* feel that winning is important in both work and games.	5	4	3	2	1
3. When I win an award or game it means that I am the best compared to everyone else that was playing. It is only fair that the best person win the game.	1	2	3	4	5
4. In school, I always liked to be the first one finished with a test.	1	2	3	4	5
5. I have always wanted to be better than others.	1	2	3	4	5
6. When nominated for an award, I focus on how much better or worse the other candidates' qualifications are as compared to mine.	1	2	3	4	5
7. I would want an A because that means I did better than other people.	1	2	3	4	5
8. Because it is important that a winner is decided, I do no not like to leave a game unfinished.	1	2	3	4	5
Scale: 8 – 40 (Total up points for IC score.)					

In assessing the success of this study in fulfilling the authors' three initial objectives: First, this research provides value in establishing at least one point of similarity between the multilevel marketing model of sales and all other tested models. Namely, that IC correlates with individual sales performance.

Second, the research did not establish whether personality and competitiveness traits predict performance differently than in other sales industries. Because the survey failed to produce a continuous dependent variable (sales performance), certain positive and negative correlations that may exist were not illuminated. The authors hope that when this study is repeated those mistakes will be corrected and the results will be compared with those from studies in other sales industries to establish whether differences exist.

Lastly, while this study did not find enough predictive traits to form a comprehensive screening tool for hiring managers, it did prove that recruiters within the multilevel marketing industry will improve their screening process by testing IC in applicants, as this trait correlated significantly with individual sales performance.

The authors maintain that value exists in determining whether different personality and competitiveness constructs predict individual sales performance differently depending on the industry or sales model. They urge other researchers to pursue this intriguing research question and build upon this study to possibly begin a new and necessary course of scholarly research.

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Multispectral Analysis of the Mangas Khipu Board

Madison Hanny and Gene A. Ware
    Utah State University

Abstract

Multispectral image (MSI) processes can greatly enhance readability of ancient documents. This study evaluates various MSI processes applied to a nineteenth-century Khipu board found in Mangas, Peru. A Khipu board is a wooden board with columns of holes in which are threaded encoded cords called khipus. Khipus use a variety of colors and knot forms to record information, though the meaning of the colors and knots remains unknown. A list of names is glued on both sides of the Mangas Khipu board. It is believed that the khipus in the Mangas Khipu board contain instructions and other encoded information that correspond to many of the listed names and that understanding this correlation may lead to the ability to decipher other khipus. However, some of the text is illegible because of dirt, bat urine, torn pages, or faded ink. It is of great interest to enhance the readability of the Mangas Khipu board to more accurately evaluate the correlation between the khipus and the text.

1 Introduction

A khipu board is a wooden board containing thread-encoded cords called khipus. One such khipu board, discovered in Mangas, Peru, by Dr. Sabine P. Hyland [1] also contains a hand-written list of names that corresponds to the khipus (Fig. 1). Multispectral images[1] of the Mangas Khipu board [2] were used for this study. The data set includes images of the front and back sides of the khipu board in 12 different wavelengths.

Fig. 1. Front and back of the Mangas Khipu board showing regions analyzed

Each side of the board is divided into 18 cells: three columns (numbered zero to two) and six rows (numbered zero to five). Each cell overlaps with those adjacent to it. When regions are cropped to be analyzed, they are identified by either a letter F, for the front of the khipu board, or the letter B, for the back of the khipu board. The letter is followed by two numbers, which indicate the column and row of the

[1] This data set includes wavelengths 400, 450, 500, 550, 600, 650, 700, 750, 800, 850, 900, and 950, regions F03, F05, F11, F15a, F15b, and F25 on the front of the board and regions B05, B13, and B15 on the back of the board.

cell in which the region is located. Figure 1 shows all of the regions used in this study and their identifications.

Over time, parts of the text on the Mangas Khipu board have become unreadable because of environmental damage and storage conditions. Five types of damage were identified to be processed and analyzed: normal text, faded text, whitened regions, bat urine regions, and dirt regions. Various image processing techniques were applied to these regions and their effects were evaluated to determine which technique best improves the readability of the document.

2   Image fusion techniques

2.1   *Principal component analysis*

Principal component analysis (PCA) is a widely used analysis technique for processing multispectral images. It uses an array of image vectors, where each image vector is created by stacking the columns (or rows) of an image on top of each other. Each source image is at a different wavelength of the same region. PCA finds the covariance of the array of images and then determines the eigenvectors of the covariance array. The dot product of an eigenvector and the array of image vectors extracts a particular component of the document [3]. Because the eigenvectors are orthogonal, PCA identifies independent components of the original images inputted. The number of components outputted is equal to the number of elements in the inputted array of image vectors. The first resulting component usually contains the best possible overall image and generally appears similar to the original color image. The remaining components contain different characteristics of the document, such as ink, background, and texture. Identifying different characteristics of the Mangas Khipu board will allow the text to be enhanced and read more easily.

PCA was applied to each of the different region types: normal text, faded text, whitened regions, bat urine regions, and dirt regions. It was found that generally component three identified the text of the khipu board, filtering out other characteristics, thus providing an image where the text was more easily read (Fig. 2). In rare cases, component four yielded more useful information than component three. For example, Figure 3 shows that PCA component four identified a stroke of ink in the image that was not identified in component three.
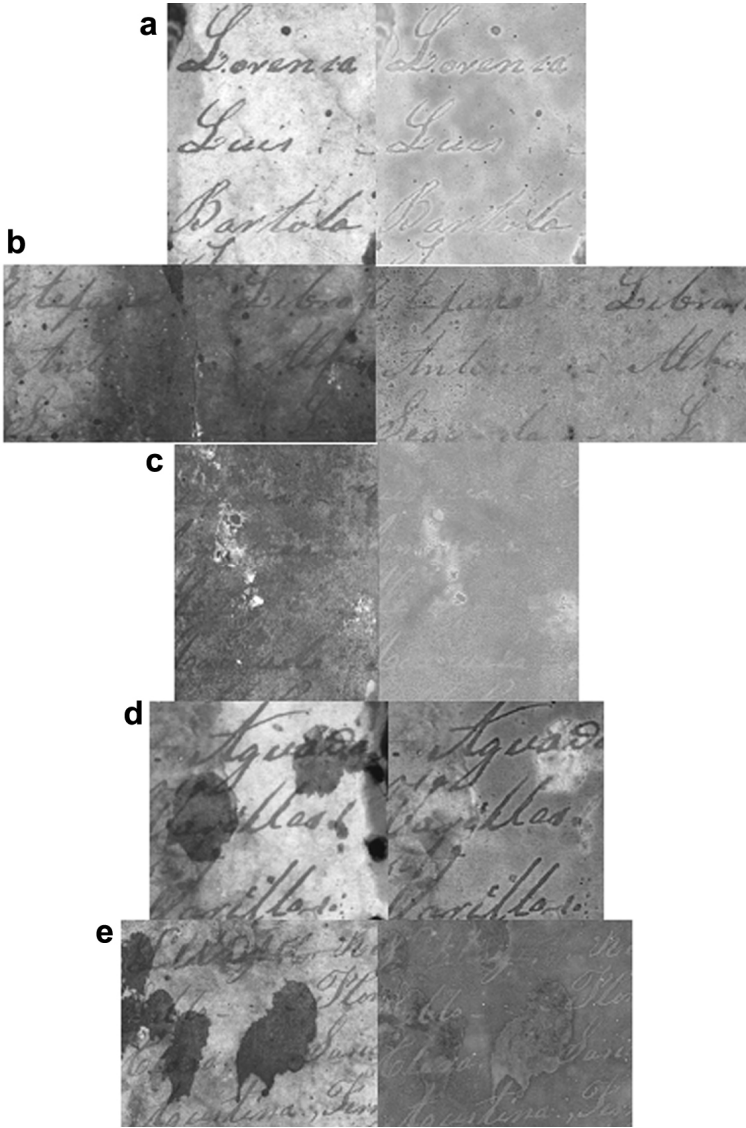
Fig. 2. Original image (left) and PCA component 3 (right) for each region type.
(a) Normal text (F11); (b) faded text (F15a); (c) whitened region (F03); (d) bat
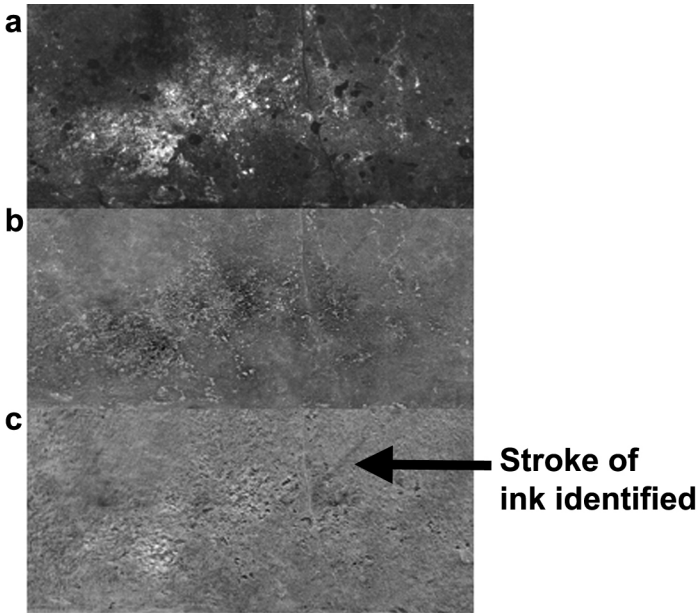urine region (B13); (e) dirt region (B15).

Fig. 3. Original image (a) and PCA components 3 (b) and 4 (c) (F15b)

3   Matched Filter Detection

Matched filter detection is a set of algorithms that can be used to identify different detail of images in an MSI data set. All 12 of the images form spectral reflectance vectors at each pixel. Each pixel vector is multiplied by a filter vector to maximize pixels containing ink and minimize pixels containing background [3]. The filters tested were clutter matched filter (CMF), spectral angle map (SAM), constrained energy minimization (CEM), and t-statistic (T-STAT). The filters differ by the detection equation used to identify pixels containing ink and background. To use these filters, the data must first be trained manually, that is, some ink and background pixels must be identified by the user. This is done by identifying the x,y coordinates of a set of pixels that the user knows contain ink and a set of pixels that the user knows contain background. The average pixel value is calculated and the filter uses these values to identify the remaining ink and background pixels in the image. For each region type, various sets of coordinates were used to find the best possible results. The same coordinate sets were used to test each filter.

3.1   Clutter matched filter

Clutter matched filter detection uses a likelihood ratio test (LRT) of the probability densities for ink pixels and non-ink pixels to determine the detection equation,

$$s^T R^{-1} x$$

where s is the ink spectrum, **R** is the covariance matrix of the data, and x is the observed data [3].

Preliminary tests showed that the CMF filter only slightly improved readability (Fig. 4). To produce better results, it was hypothesized that training the data using pixel values contained only within obscured regions would allow the detector to better differentiate the text from the background. Testing this hypothesis proved to yield better results. It was found that the best CMF resulted when the data were trained using pixels located in obscured area (Fig. 5).

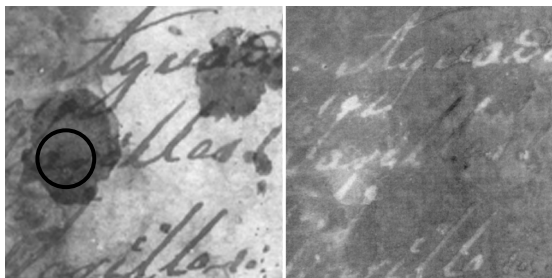**Fig. 4.** Original image (left) and CMF results (right) (B13)

Fig. 5. (Left) Pixels (circled) in an obscured area of the original image used to train the data and (right) and CMF results (B13)

3.2   Spectral angle map

A simple way to determine the filter vector is to use the trained ink pixels, or the ink spectrum. This spectrum is usually greatly affected by the energy of the background spectrum. Dividing by both the energy of the ink spectrum and the energy of the background spectrum yields the SAM detector, whose detection equation is

$$\frac{s^T x}{\sqrt{s^T} \cdot \sqrt{x^T x}}$$

where s is the ink spectrum, x is the observed data, sqrt($s^T s$) is the energy of the ink spectrum, and sqrt($x^T x$) is the energy of the background spectrum [3].

The SAM filter identified the text of the Mangas Khipu board best on normal text, faded text, and dirt regions (Fig. 6); however, some of the images needed to be enhanced to improve the contrast between the background and the ink for the results of this filter to be useful.   The SAM filter provided the best results when the data were trained using pixels clearly identified as ink (similar to the CMF filter).

SAM is especially useful in identifying different inks. Notice that in Figure 6c part of the text appears black and the remaining text appears white. This is because the word *Lucia* was written in pencil and is detected differently than the rest of the ink in the image. It is clear from Figure 6c that there was something written underneath *Lucia* and part of that ink is identified using the SAM filter. Also, the ink underneath the dirt appears slightly darker than the rest, but is still identified and enhances readability of the khipu board.

3.3   Constrained energy minimization

The CEM uses an ink spectrum vector to minimize the filter output energy. Its detection equation is

$$\frac{s^T \Gamma_x^{-1} x}{s^T \Gamma_x^{-1} s}$$

where s is the ink spectrum, Γ is the correlation matrix of the data, and x is the observed data [3].

Fig. 6. Original images (left) and SAM filter results (right) for various region types. (a) Normal text (F11); (b) faded text (F25); (c) dirt region (B15).

The CEM filter performed text identification very well on normal text no matter which of the pixels used to train the data. This filter was able to identify text specifically in obscured areas when tested on a bat urine region of the khipu document. This is beneficial because the goal of these processes is to enhance readability in regions of the document

that are difficult to read, such as bat urine regions. The CEM filter also identified text well in regions where the text has faded (Fig. 7). The CEM filter gave the best results in text identification for regions with bat urine and faded text when the pixels used to train the data were nearly obscured as shown in Figure 8. Note that the data used are called "nearly" obscured because the obscured ink is generally not differentiable from the obscured background and cannot be used to train the data.

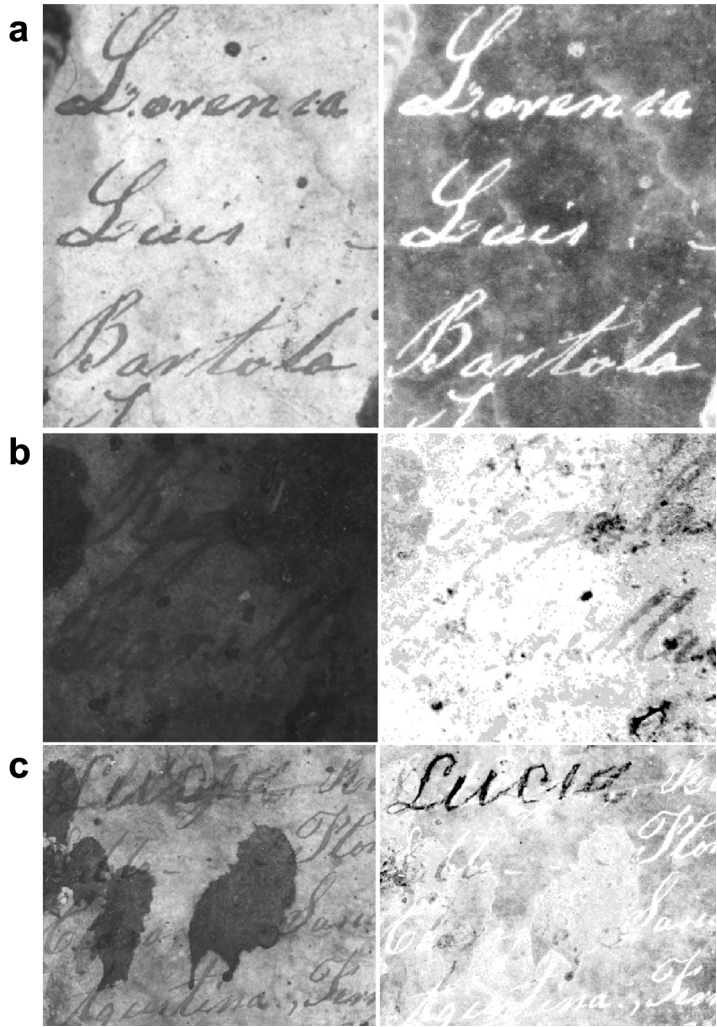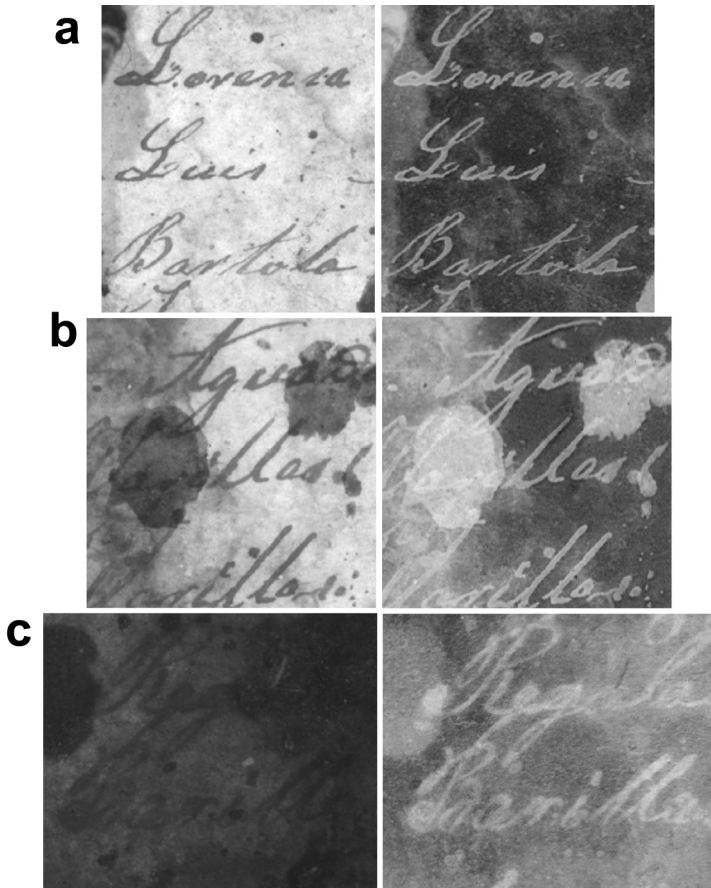**Fig. 7.** Original images (left) and CEM filter results (right) for various region types. (a) Normal text (F11); (b) bat urine region (B13); (c) faded text (F25).
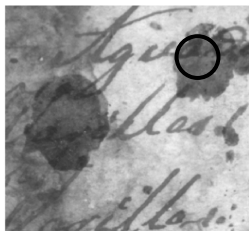
Fig. 8. Pixels used to train the data to get optimal results from CEM filter (circled) (B13).

3.4   T-Statistic

The *t*-statistic filter (T-STAT) is the square root of the ratio between the CMF and the sum of squares due to error. The detection equation for this filter is

$$\frac{s^T \mathbf{R}^{-1} x \, \rho \sqrt{(d-1)}}{\sqrt{x^T \mathbf{R}^{-1} x - \rho^2 (s^T \mathbf{R}^{-1} x)^2}}$$

where s is the ink spectrum, **R** is the covariance matrix of the data, x is the observed data [3].

The T-STAT filter yielded the best results and provided the most new and useful information when the pixels used to train the data were nearly obscured (Fig. 9). It was found that the T-STAT filter identified text of the Mangas Khipu board well in all region types (Fig. 10). Thus, it was the most useful filter in identifying text of the khipu board overall, but when considering a specific region type, it may have not provided results as useful as another filter.

Fig. 9. Pixels used to train the data to get the best results of the T-STAT filter represented by light gray spots (F25).

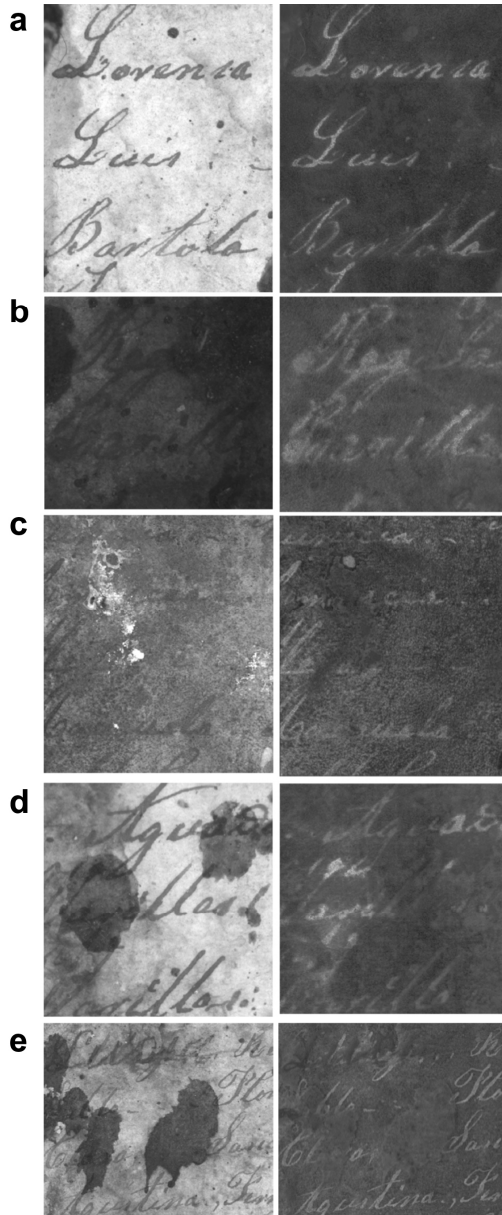**Fig. 10.** Original images (left) and T-STAT filter results (right) for each region type. (a) Normal text (F11); (b) faded text (F25); (c) whitened region (F03); (d) bat urine region (B13); (e) dirt region (B15).

4   Observations and Conclusions

The Mangas Khipu board contains text that in some places is un-readable because of environmental damage and storage conditions. This study applied various image processing techniques to the khipu board to enhance its readability. Each technique was applied to each region type (normal text, faded text, whitened regions, bat urine regions, and dirt regions) using various sets of trained data. The results were compared to find the technique that enhanced the readability the best for each region type (Table 1).

Table 1: Summary of usefulness of processing techniques on each region type	
Region Type	**Processing Techniques (in order of usefulness)**
Normal Text	PCA, CEM SAM CMF T-STAT
Faded Text	CEM CMF T-STAT SAM PCA
Whitened Region	T-STAT, CMF CEM PCA SAM
Bat Urine Region	PCA CEM CMF, T-STAT SAM
Dirt Region	PCA SAM T-STAT CEM, CMF

In the normal text region, PCA and the CEM filter were able to identify the text of the khipu board very well. The CEM filter yielded good results no matter which pixels were used to train the data. The SAM and CMF filters also provided enhanced readability. The T-STAT filter enhanced readability, but only slightly (Fig. 11).

Fig. 11: Results of processing techniques for a normal text region (F11). (Left to right) PCA, CEM, SAM, CMF, T-STAT.

In the faded text region, the CEM and the CMF filters both provided enhanced readability by identifying ink in the image sufficiently. The T-STAT filter identified ink sufficiently and the SAM filter (after being enhanced) provided sufficient results to make the text of the khipu board readable. The SAM filter may provide better readability if the result was applied to the original color image as a mask. The PCA results did not enhance readability (Fig. 12).
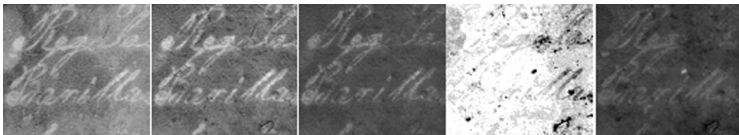
Fig. 12: Results of processing techniques for a faded text region (F25). (Left to right) CEM, CMF, T-STAT, SAM, PCA.

In the whitened region, the T-STAT and CMF filters were able to identify some text that is not visible in the original images. The CEM filter and PCA enhanced readability slightly. The SAM filter did not provide useful or new information to enhance the readability of the text (Fig. 13).

In the bat urine region, PCA identified the ink very well through the darkened areas. The CEM, CMF, and T-STAT filters were able to identify ink in areas of the text that were hard to read before applying the filter. The goal of these processing techniques is to enhance readability in the areas that are illegible to the naked eye. Thus, those filters accomplished this goal. The SAM filter slightly enhanced readability in the bat urine region (Fig. 14).
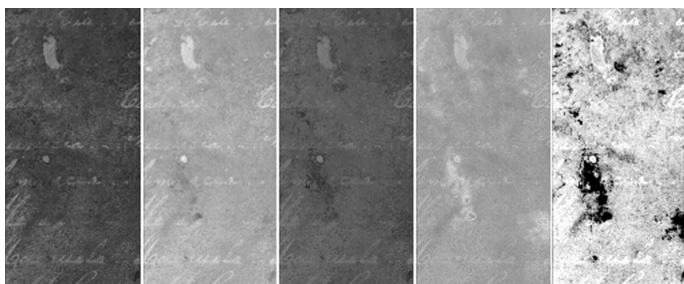
Fig. 13. Results of processing techniques for a whitened region (F03). (Left to right) T-STAT; CMF, CEM, PCA, SAM.
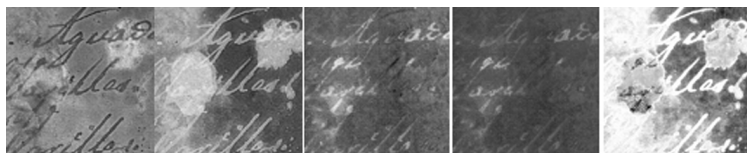
Fig. 14. Results of processing techniques for a bat urine region (B13). (Left to right) PCA, CEM, CFM, T-STAT, SAM.

In the dirt region, PCA was also able to identify the text of the khipu board well to enhance readability. The SAM filter was able to identify different types of ink. That is, when there was some writing in pen and something writing in pencil in the same image, the SAM filter identified the different writing mediums (Fig. 15b). This is useful when there was something written on top of other text that was formerly there. The SAM filter was also able to identify ink through the dirt on the khipu board. The T-STAT filter enhanced readability slightly. The CEM and CMF filters did not enhance readability (Fig. 15).
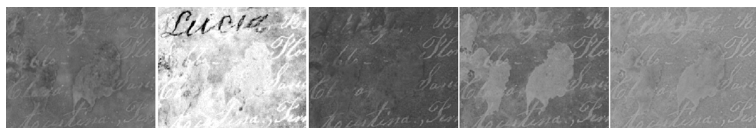
Fig. 15. Results of processing techniques for a dirt region (B15). (Left to right) PCA, SAM, T-STAT, CEM, CMF.

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Jet Flow Behavior Observed During Microgravity Boiling

Troy Munro and Heng Ban
Utah State University

Abstract

A thin-wire, subcooled boiling experiment was performed onboard an aircraft flying a parabolic trajectory as a means to provide microgravity conditions. Microgravity allows for improved observation of jet flow phenomena and the ability to investigate their behavior in the absence of buoyant forces. A new mode of jet flows was observed in microgravity that accounts for the high heat fluxes measured on the wire heater. A relative bubble area analysis method was able to quantify vapor production and bubble behavior across multiple frames of video. A cross-correlation calculation similar to particle image velocimetry (PIV) provided velocities of the micro-bubbles in the flow. These micro-bubble jet flows and the convection currents they induce have the potential to allow for sustained boiling to occur in microgravity at high heat fluxes.

I. Introduction

Because of the high heat transfer rates associated with boiling, it is used in many energy production and thermal management systems. Although correlations based on experimental studies have been developed for practical application of boiling heat transfer, these correlations are limited in their scope to thermal systems that are similar to the experiment on which they were based. Additionally, these correlations are unable to provide a prediction of what the boiling behavior would be for a new system and are unable to capture the many nonlinearities and complex interactions that exist in boiling. An example of this is shown in Rohensow's widely used pool boiling nucleate boiling correlation, Equation 1 [1,2], which predicts the heat flux dissipated during boiling based on thermal responses of the fluid and buoyant forces.

$$q_s{}^n = \mu_l h_{fg} [g(\rho_l - \rho_v)/\sigma]^{1/2} ((c_{(p,l)} \Delta T_e)/(C_{(s,f)} h_{fg} [(\mathrm{Pr})]_l{}^n))^3 \quad (1)$$

Application of Eq. 1 in a microgravity system predicts that the heat flux q_s'', heat per unit area, dissipated by boiling heat transfer approaches zero as the gravity force approaches zero.[1] Many experiments [3-5] have shown that this is not the case. Therefore, a predictive model that incorporates the mechanisms involved in boiling would be much more useful than an empirically based correlation. Dhir [6] has found success in the use of numerical simulations to predict boiling in a few instances [7-12], but he concludes that there is a need for further study to understand the physical processes involved in boiling. This paper examines the behavior of a physical process called jet flows in a microgravity environment, where buoyant forces are removed.

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[1] **Nomenclature**

$q_s{}^n$ = heat flux at surface

μ_l = liquid viscosity

h_{fg} = latent heat of vaporization

g = gravitational acceleration

ρ_l = density of liquid

ρ_v = density of vapor

σ = surface tension

$c_{p,l}$ = specific heat of liquid

ΔT_e = temperature difference between surface and bulk fluid

$C_{s,f}$ = constant

Pr_l = Prandlt number of liquid

Jet flows are bubble behaviors that often exist during subcooled boiling, where the bulk temperature is below saturation temperature. Surface tension gradients along the bubble face, due to temperature variations between the heated surface and the subcooled surface, result in flow along the vapor–liquid interface, referred to as Maragoni, or thermocapillary, convection. This flow causes oscillatory, localized destruction of a metastable, superheated boundary layer [13], which can form a jet flow.

Wang et al. [14] have characterized several different modes of jet flows. The high-energy liquid jet occurred when a thin wire was placed in a pool of liquid ethanol at 23°C (55K subcooling) and a current of 2.07 A was passed through the wire, resulting in a heat flux of 300 kW/m^2. Although no bubbles generated from nucleation sites, a flow of high-energy liquid was observed to depart from the wire and disappear after 1–3 mm into the bulk fluid. The fog-like jet was observed within liquid ethanol at atmospheric pressure 45°C (33K subcooling) and at an applied current of 4.5 A, resulting in a heat flux of 1000 kW/m^2. Fog-like jet structures that had no distinct bubble-form generated from active nucleation sites, spraying from site and disappearing at a distance of 7 mm from the wire heater. The cluster-like jet was observed at bulk fluid temperatures near saturation and at a heat flux of 800 kW/m^2. The jet flow was characterized by small liquid masses that absorbed a significant amount of heat but did not nucleate into vapor bubbles. Additionally, because the bulk fluid was near saturation temperature, the flows did not condense like the high-energy liquid jet did.

Further work by Wang's colleagues [15,16] characterized additional, more stable modes of jet flows. The most significant mode is the bubble-top jet, which forms at the top of small bubbles on the wire. This mode existed when the level of subcooling was greater than 30K and was characterized by a semi-transparent jet of fluid at the top of a bubble that penetrated deep into bulk fluid. This mode of jet flows is caused by the pumping effect of the growing bubble [17], which causes the bubble to pump the fluid in its vicinity toward the top of the bubble and out into the fluid at velocities of 10–150 mm/s. When the bubble that participated in the bubble-top jet flow grew to a size comparable with that of the wire, a new multi-jet flow was observed. In this jet flow, two jets flow out from the interface of the wire and the bottom of the bubble, resulting in a butterfly-like structure. Velocities of this mode of jet flow were 30–160 mm/s [18].

Lu et al. [19] characterized a final mode of jet flow called the small, explosive bubble boiling. This mode was observed at heat fluxes greater than 2000 kW/m^2 and was characterized by small vapor bubbles with a diameter of about 10 μm that departed from the wire. As the heat

flux was increased, fewer jet flows formed, the diameter of the bubbles increased, and the frequency of departure increased. The current study characterizes a similar jet flow mode, called micro-bubble jet flow, that is characterized by larger vapor bubbles, a different form of the jet flow, and self-organization of the jet into combined flow.

To study fluid velocities, traditional use of particle image velocimetry (PIV) involves a light sheet from a pulsed laser, a high-speed camera, and tracer particles to match the motion of the fluid in question. Use of this method in boiling research has resulted in velocity data for bubble growth and departure [20] and the development of bubble-top jet flow [21,22]. Additionally, traditional PIV has been used to verify numerical models of bubble sweeping flows and the jet flows they trail [23,24]. Velocities of the fluid pumped by this jet flow were on the order of 10–140 mm/s [21,25], while the velocity of the bubble sweeping along the wire was lower, 20–50 mm/s [23]. In boiling experiments, bubbles can be directly visualized instead of additional tracer particles, and the resulting cross-correlation computation represents bubble velocities, which may or may not represent fluid velocity depending on the size of bubbles and buoyancy effect. However, little work has been done to investigate the fluid motion of other modes of jet flows by means of traditional PIV or by a bubble image velocimetry. This could be because of the inability of tracer particles to accurately mimic these flows or the sensitivity of different jet flow modes to lighting conditions. The term PIV is used in the remainder of the paper to represent bubble image velocimetry, where the bubbles are cross correlated between frames of video.

The current study discusses a method based on a DaVis 7.2 PIV algorithm for the approximation of jet flow velocities of some of these other jet flow modes, which has not been investigated in the literature. Through the use of PIV, a relative bubble area analysis, and visual observations, the characterization of a new jet flow mode is made.

2. Experimental Setup

Two different sets of experiments, the first being a free-floating experiment and the second attached to the floor of the plane, were flown on an aircraft flying a parabolic trajectory. Each experiment used identical fluid chambers to provide similar initial conditions for boiling on thin wires. The free-floating experiment used 15 of these fluid chambers, including 5 containing a single 130-μm-diameter platinum wire, 5 containing a twist of three 76-μm-diameter platinum wires, and the 5 containing a twist of four 51-μm-diameter platinum wires. The attached experiment used 20 fluid chambers where half contained a

single 130-µm-diameter platinum wire and the other half contained a twist of three 76-µm-diameter platinum wires. All wire geometries are shown graphically in Fig. 1a, and the diameter of each wire was chosen to produce cross sections with similar areas and comparable resistances (±8%). Each wire was 1 cm long and was connected to the ends of two stainless steel rods by means of electrical terminals, which pinched the wires at the ends. These stainless steel rods protruded into the fluid chamber from the instrument panel and provided electrical power and structural support for the wire heater (Fig. 1b). This instrument panel also had a ladder of four Type T thermocouples located below the heating wire to provide initial bulk temperatures and to measure the thermal response of the water away from the wire. Each fluid chamber contained 164 mL of deionized water that was degassed through boiling under a vacuum before the filling of the fluid chamber. Polycarbonate walls, an O-ring, and epoxy seals allowed for flexing of the side walls to reduce the effects of internal pressure changes because of vapor formation.
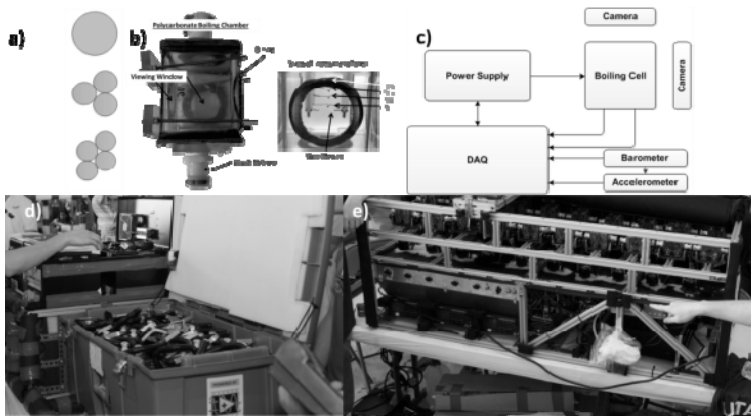
Fig. 1. Flight equipment description: wire heater cross-sections (a), fluid chamber diagram (b), system diagram (c), free-floating test rig (d), and attached test rig (e)

During each microgravity parabola, the free-floating experiment tested three fluid cells, each with a different wire geometry, while the attached experiment tested two fluid cells. Operation of each experiment was the same and followed the schematic shown in Fig. 1c. The data acquisition system would select one of eight pre-programmed constant current levels, which would then provide power from separate DC

power supplies to each of the wire heaters. Voltage and current meas-
urements of the wire heater were taken at approximately 10,000 Hz,
with the average and standard deviation being recorded every 10 ms.
Pressure and accelerometer measurements were taken in the same man-
ner and resulted in an ambient pressure of about 82 kPa and an average
acceleration near 10^{-2} g. Fig. 2 shows a typical acceleration profile for
the microgravity portion of the plane's parabolic arc. Thermocouple
measurements were taken at 75 Hz. Two orthogonal, high-definition
cameras provided image capture for each fluid cell, and through use of
magnifying lenses, a pixel resolution of 14×14 μm was achieved.
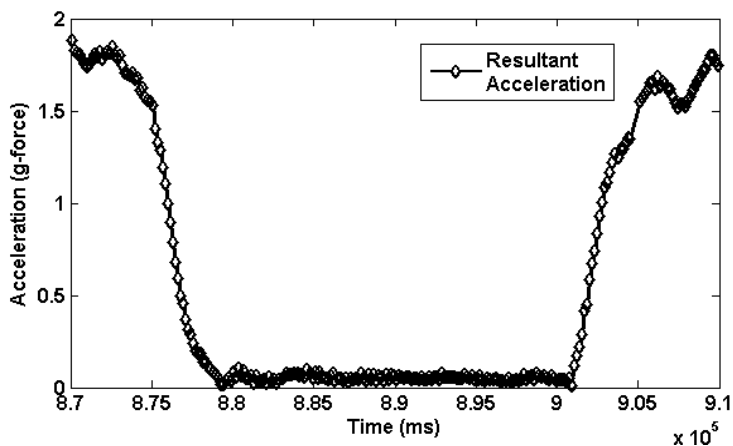
Fig. 2. Acceleration during microgravity portion of parabola

The free-floating experiment (Fig. 1d) used two diffused red
LEDs and one harsh white LED to provide a balance between visibility
of both isolated bubbles and jets flows. Additionally, heat fluxes ex-
perienced by this experiment are in the low to medium range (500–
1200 kW/m²). To compare the effect of lighting on jet flow visualiza-
tion and to provide higher heat fluxes, the attached experiment (Fig. 1e)
used a single harsh white LED light and experienced heat fluxes from
500 to 5100 kW/m², at which point burnout occurs on the single wire.
One of the issues with determining the average heat flux of each wire
geometry is that the heat flux is not axisymmetric for the twisted wire
geometries because of localized heating in the crevices. To take this
into consideration, the heat flux for the three-wire geometry was calcu-
lated based on the external surface area of the three-wire twist, which is
5/6 of three separate cylinders, to exclude the area in the crevice. Simi-

larly, the four-wire geometry was treated as four separate cylinders and then multiplied by 3/4. The unique surface geometry of the three-wire geometry causes a lower heat flux to be dissipated for the same applied current.

3. Results and Discussion

3.1. Jet flow characteristics

Visual observations made by high-definition cameras allowed the development of the micro-bubble jet flow to be captured across multiple frames of video. Figure 3 shows the development of several of the micro-bubble jet flows on the top, middle, and bottom of the wire. The micro-bubble jet flow is characterized by the departure of small vapor bubbles, on the order of 100 μm, directly from the wire. Multiple columns of these small bubbles form on a 1- to 2-mm-long region of the wire. Farther away from the wire and as time passes, the columns combine and depart from the wire with a combined jet diameter of 3–4 mm.
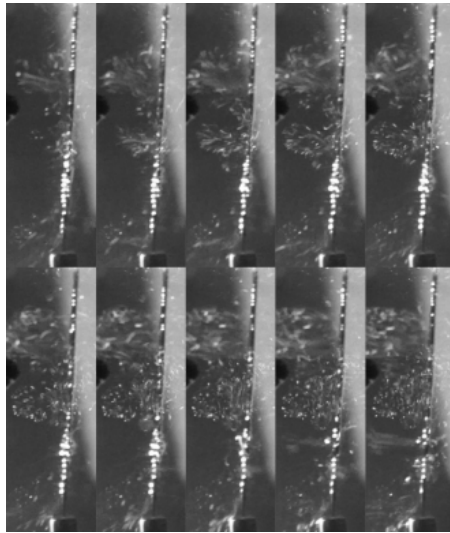

Fig. 3. Development of micro-bubble jet flow after initiation of boiling

This combined jet diameter is in contrast to the thin plumes that are seen above bubble-top jet flows observed during this same experiment, which are on the order of tens of microns. It is expected that the velocities of the micro-bubble jet flows are lower than what has been reported

for other types of jet flows [21-25] because of the larger diameter of the combined jet flows and the flow consisting of a liquid and vapor cloud. The microgravity environment allows the combination of jet flows into the bulk fluid to be seen when buoyancy effects would obscure these self-organized flows. Additionally, the three-wire geometry is observed to form micro-bubble jet flows more readily than the single wire. During the few instances when micro-bubble jet flows were observed on the single wire, the bubbles were smaller and less visible, similar to the observations of Lu et al. [19], and the flows did not combine and self-organize like the flows observed on the three-wire.

Additionally, visual observations show that at higher heat fluxes, the micro-bubble jet flow mode begins to dominate the bubble behavior on the wire. This behavior is seen in Fig. 4a, where micro-bubble jet flows are seen to exist along the entire length of the wire, and Fig. 4b provides an illustration of the jet flow departing in multiple columns of bubbles from a region of the wire and combining into a larger flow. At higher heat fluxes, the departure of vapor bubbles is more frequent, and isolated bubbles cease to be present on the wire. However, as the heat flux approaches the critical heat flux of the system and the wire is in danger of burning out, isolated bubbles begin to form again (first frame of Fig. 5). These bubbles begin to insulate the wire locally, causing the wire to increase in temperature until the melting temperature of the wire is reached and the wire burns out (middle frames of Fig. 5). Burnout occurred on the single wire geometry at a heat flux of 5100
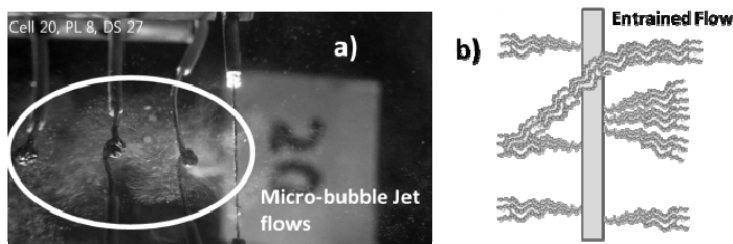

Fig. 4. Image showing micro-bubble jet flow dominant behavior on wire (a) and an illustration of the behavior of the micro-bubble jet flow (b)

kW/m^2 but was not observed on the three-wire geometry. At the highest heat flux experienced by the three-wire (2800 kW/m^2) and near the critical heat flux of the single wire, micro-bubble jet flows and isolated bubbles were both present.
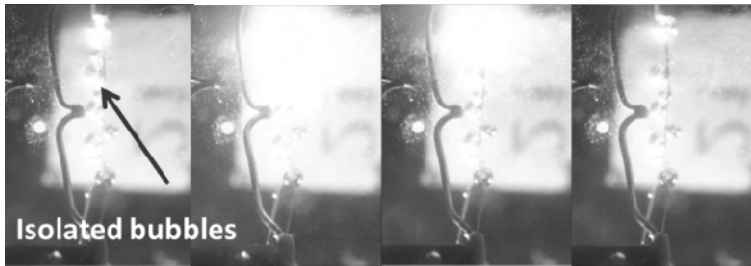
Fig. 5. Burnout of wire at critical heat flux after isolated bubbles reappear on the wire

3.2 Bubble image velocimetry – methods and results

In traditional PIV, the basic setup consists of a pulsed laser to reduce particle blurring between frames, optics to turn the laser beam into a laser sheet to represent a plane of flow, micron-sized tracer particles to visualize but not interfere with the flow of interest, and a high-speed camera to capture sequential images of the flow and tracer particles. The digital images (Fig. 6a) are subdivided into smaller interrogation windows (Fig. 6b-c), and the interrogation window of the first image is cross correlated with the corresponding interrogation window of the second image. Cross-correlation is a statistical method that basically multiplies the numerical values of each pixel in the images as the two images are "slid" past each other in every direction. The result is a correlation peak (Fig. 6d), and the distance and direction of this peak in reference to center of the interrogation window represents the displacement of the tracer particle. This displacement vector is then divided by the amount of time that passed between the two images to represent the velocity of the tracer particle and the fluid flow at that location [26].

A cross-correlation calculation similar to PIV was used to approximate the velocity of the vapor bubbles in the micro-bubble jet flow. In this bubble image velocimetry, the small vapor bubbles become the portions of the images that are tracked across the frames, rather than tracer particles. These bubbles are made visible by use of a harsh LED light, rather than a pulsed laser, lower frame rate cameras,
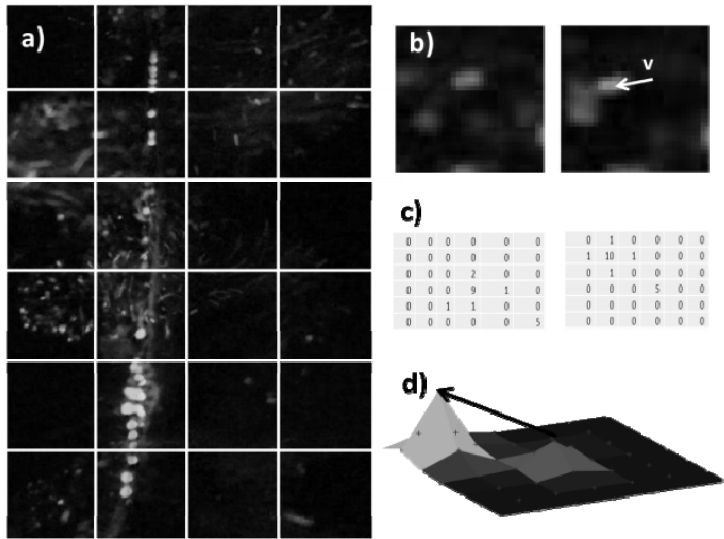
Fig. 6. Description of PIV process. Digital image (a), interrogation windows (b), pixel values in interrogation window (c), and correlation peak showing motion of particle (d)

and the microgravity environment. To isolate the vapor bubbles in the image, the frames of video are averaged and the background subtracted. These grayscale images are then analyzed in a two-pass pattern of inter-rogation windows of sizes 128×128 pixels and 32×32 pixels. Although there are issues by assuming planar flow to allow for cross correlation, the results of this method agree within ±2 mm/s according to manual vapor bubble tracking. Typical velocities of these micro-bubble jet flows are on the order of 4 mm/s to 14 mm/s and contour maps of the fluid velocity are able to show the structure of the jet flow at different times (Fig. 7). Each structure shows the combined micro-bubble jet flow in the bulk fluid, and this combined flow can cause convective currents in the bulk fluid that would not normally be present. This con-vective flow in microgravity is important because it can compensate for the lack of buoyant motion and aids in vapor removal from the wire.

3.3 Relative bubble area – methods and results

While many boiling experiments record visual data, these data are often limited to qualitative observations, and there are few analytical
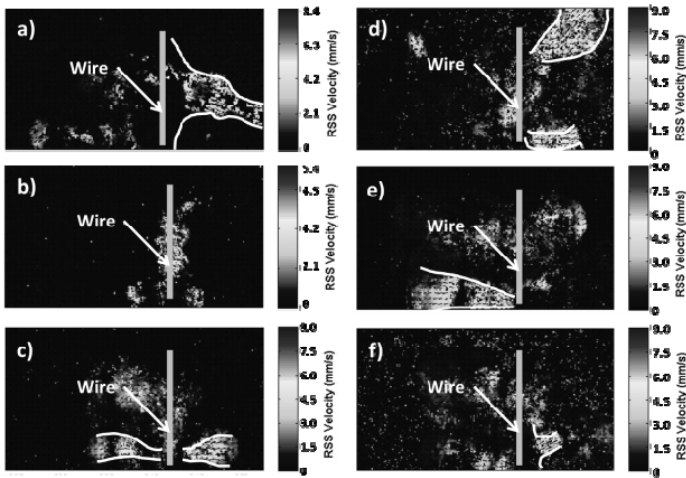
Fig. 7. Jet flow structures shown through PIV method. Single, combined jet (a), jet formation after boiling onset (b), symmetric jet (c), two jets (d), dispersed jet (e), and single jet (f)

methods for these visual data. Typically, relationships between heating element temperature measurements and bubble dynamics would come from bubble diameter or bubble number measurements, which can be difficult and time-consuming to gather for multiple frames of video and multiple tests. Therefore, a need exists for a method of data reduction to allow for the quick and accurate quantitative analysis of visual data to compare the effects of varying system parameters on bubble dynamics.

A new method of relative bubble area analysis has been developed to provide this quantitative analysis method. The method simply sums the number of pixels in an interrogation window that captures the wire and 2 mm of the surrounding water in a particular grayscale frame that have changed since a designated initial frame, while compensating for any shakiness in the video. This initial frame contains the pixel values for the background of the video, and the formation of bubbles changes these values. To balance the presence of false negatives and false positives, a threshold value is used to decide how much a pixel value needs to be changed to be counted in the method. Because this method only counts the number of changed pixels, rather than searching for each bubble, it does not contain information on absolute bubble diameters or bubble counts. Rather it provides a measure of how much

bubble area is present relative to other tests and is can be viewed as an approximation of the volume of vapor formed. Equation (2) provides a description of the algorithm used in the relative bubble area analysis, for reference.

$$[\mathbf{Frame}]_{i,j}^{n} - [\mathbf{Frame}]_{i,j}^{initial} \begin{cases} > threshold, count pixel \\ < threshold, ignore pixel \end{cases} \quad (2)$$

The threshold value for the current study was set at 45 and reduced the number of pixels that are counted along the thermocouples to the left of the wire. Fig. 8b shows the changed pixels of a representative frame from the video for a heat flux of 520 kW/m^2 experienced by the single wire, while Fig. 8a shows the initial frame used in the relative bubble area analysis method. Use of this method allows the vapor behavior of an entire video to be represented in a single graph and the effects of system parameters to be compared across different sets of data.
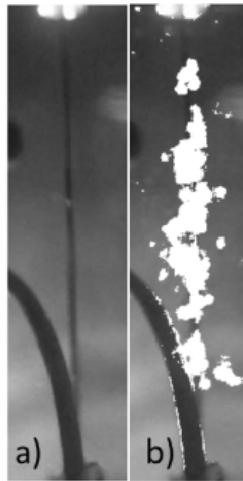
Fig. 8. Relative bubble area method showing the initial frame (a) and later frame with changed pixels (b)

Application of the relative bubble area method to videos from the free-floating experiment showed a transition over time, where the dominant form of vapor bubbles transitioned from isolated bubbles shortly after boiling was initiated to jet flows after boiling had occurred for about 10 s. This behavior is shown by the slashed line of the single

wire in Fig. 9, where the percentage of changed pixels decreases as time passes. This is due to the development of jet flows that are not visible because of the diffused lighting of the free-floating experiment. Because the flows are not visible, they do not contribute to the relative bubble area, resulting in the drop. In this way, the relative bubble area method is able to capture the time-based transitional behavior of jet flows. However, the length of time that this transition takes means that there is some unknown transient behavior causing this bubble transition. The wire heater's thermal response cannot explain this transition because it has a relatively short transient behavior. Additionally, Fig. 9 shows that the twisted wire geometries can exhibit different bubble behaviors than the single wire.
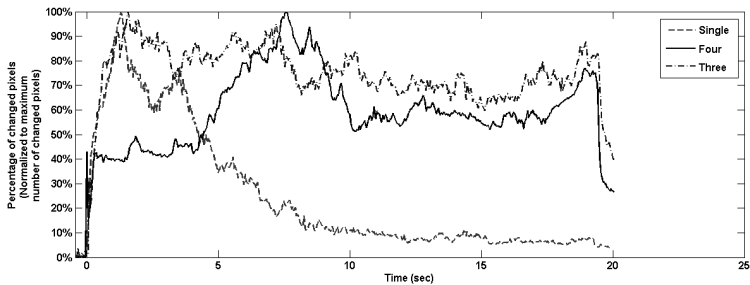
Fig. 9. Relative bubble area of free-floating experiment showing bubble type transition over time, normalized by the maximum number of changed pixels for each wire geometry

As mentioned above, the diffused lighting of the free-floating experiment decreased the visibility of jet flows on the wire, which affected the relative bubble area. The attached experiment used harsh LED lighting to illuminate jet flows and resulted in a different response in relative bubble area. Fig. 10a shows what the relative bubble area of isolated bubbles looks like, while Fig. 10b shows what the relative bubble area of jet flows looks like during the attached experiment. Results from the free-floating and attached experiments show that lighting can be manipulated to either illuminate or obscure jet flows and that the relative bubble area method can be used to capture different bubble behavior for both lighting configurations. This aids in the characterization of the micro-bubble jet flow being composed of bubbles about 100 μm in diameter departing in multiple columns from a region of the wire.
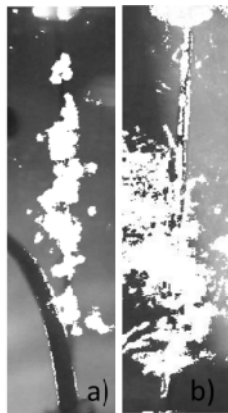
Fig. 10. Relative bubble area for attached experiment showing isolated bubbles (a) and jet flows (b)

Additionally, the relative bubble area method's ability to compare bubble behavior across system parameter variations was able to observe a heat flux–based transition during boiling. Figure 11 shows the relative bubble area results for all microgravity tests performed with the single wire during the free-floating experiment. Line 1 represents a heat flux
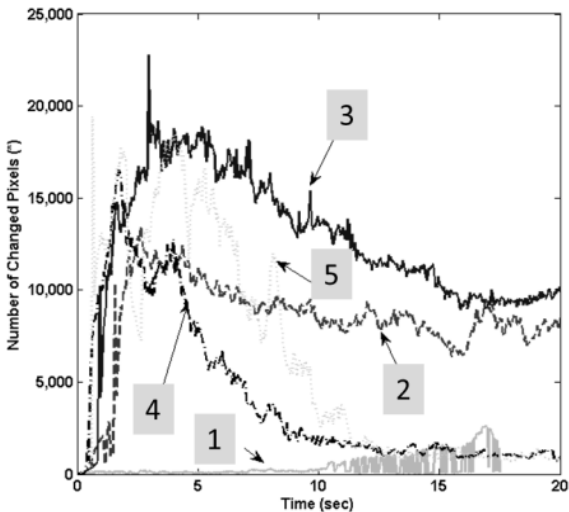
Fig. 11. Relative bubble area results for increasing heat fluxes 1-5

where boiling did not occur and the relative bubble area registered changed pixels for heat distortion caused by superheating of the fluid near the wire. As the heat flux increases, line 2 shows an increase in relative bubble area as the growth of isolated bubbles is captured, and the relative bubble area reaches a maximum at line 3 where large, isolated bubbles have formed along the entire wire. Because of diffused lighting, the relative bubble area decreases for lines 4 and 5 as jet flows form but are not counted by the method. In this way, bubble behavior is shown to be dominated by isolated bubbles at low heat fluxes (Fig. 11, lines 2–3) and by jet flows at higher heat fluxes (Fig. 11, lines 4–5).

4. Conclusions

Analysis of both microgravity experiments has led to the following conclusions:

- A new jet flow mode was observed, called the micro-bubble jet flow, which is characterized by small, 100-μm-diameter-sized bubbles departing in multiple columns from the wire. The columns combine to form a jet flow with a diameter of 3–4 mm and penetrate tens of millimeters into the bulk flow with a velocity of 4–14 mm/s.
- Combined micro-bubble jet flows were able to induce fluid motion in the bulk fluid.
- Cross-correlation calculations can be made using vapor bubbles as the tracer particles, in a bubble image velocimetry. This method is able to capture and track the development of micro-bubble jet flows and illustrate their effect on the bulk fluid.
- A relative bubble area analysis was developed, which was able to characterize the time- and heat flux–based transitions that occur in boiling systems that exhibit jet flows.

5. Acknowledgments

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The Acquisition of Three Infinitival and Three Conjunctional Phrases: Establishing a Hierarchy of Difficulty

Rachel W. Kirk
Southern Utah University

Abstract

This article examines the acquisition of the structures para/antes de/sin + infinitive and para que/antes de que/sin que + subjunctive by intermediate and advanced intermediate students at the secondary level. Processing instruction (PI) alone and three combinations of PI and meaning-based production practice were used. The results of a pretest, two post-test design indicated a hierarchy of difficulty among the three structures with subjunctive and the three with infinitive. According to this study, the hierarchy of difficulty among the structures with infinitive appears to be para < sin < antes de. Of the constructions with subjunctive, the order of acquisition seems to be para que < antes de que < sin que.

Introduction

The subjunctive has long been a stumbling block for intermediate students of Spanish. Many authors (e.g. Zucker, 1977; Bell, 1980; Collentine, 1998) have written about the large number of rules involved in learning how to use the subjunctive correctly. Some authors have tried to reduce the subjunctive to fewer rules or even to just one (Bergen, 1978).

Although the subjunctive in general can prove difficult, conjunctional phrases such as *para que, antes de que,* and *sin que + subjunctive* are often viewed as "easy" because they always require the subjunctive; however, these "easy" structures are often misused by students and even by their professors (Faingold, 2004).[1] This article is the continuation of Kirk (forthcoming), which describes the acquisition of the infinitival structures described here by students at the secondary level. Among the conclusions were that the results of processing instruction (PI) alone were equal to or superior to the combination of PI and meaning-based output (production) practice and that, for the acquisition to be lasting, more time needed to be devoted to PI than to output practice. This article takes the findings one step further, dividing and examining the participants' progress structure by structure, with the intent of establishing whether there is a hierarchy of difficulty among the grammatical structures included here.

Processing instruction was introduced to the world of second language acquisition nearly 20 years ago (VanPatten and Cadierno 1993). Proponents of PI claim that its "structured input" activities transform the strategies by which the brain processes language components. In those activities, input is structured in such a way to rewire language processing mechanisms in the brain, enabling students to acquire structures that work differently in the first language and the second language. Helping the brain learn to process the structures in the same way the brain of a native speaker might process those structures is referred to as resetting parameters (White 2003).

Before carrying out the present study, it was necessary to determine why learners were having trouble deciding when to use the structures with infinitive (*para/antes de/sin + infinitive*) and when to use those with the subjunctive (*para que/antes de que/sin que + subjunc-*

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[1] Penadés Martínez (2005) pointed out the lack of attention structures such as the ones included in the present study have received in the area of Spanish as a Second Language. These structures were good candidates for processing instruction because they are often overlooked, because they are acquired late (Faingold, 2004), and because the structures are quite different in the students' L1 (English) than they are in Spanish.

tive). In fact, although students' accuracy with other structures requiring the subjunctive was progressing nicely, their usage of these structures completely stalled. The explanation is twofold. First, the words in English, the learners' first language, are the same or similar no matter which structure is required in Spanish. *Before* is expressed by both *antes de* and *antes de que; sin* and *sin que* are both translated *without* in English. The meaning of *para que* and *para* can be transmitted by the words *so that,* although *para* is usually translated *in order to* before an infinitive.

Second, in English (the participants' native language), the subjunctive is not used after the words *before, so that,* or *without,* and in only one case *(in order to)* is the infinitive used. For the subjunctive to be used with these words in Spanish, a change of subject is mandatory; when there is no subject change, we use the structures with infinitive.

Research Questions

The ease of acquisition of all of the grammatical structures included here has not been examined previously. There are two questions of central importance to this article. First, are some structures included in this study more easily acquired than others? Second, if it is possible to establish an order of difficulty among the structures included in this study, which structures are acquired more readily, and which are more stubborn? A third question, to be examined in a future paper, pertains to possible factors that might contribute to such a hierarchy of difficulty.

Methods and Procedures

Participants

The first part of this study was carried out at the secondary level, in authentic Spanish IV (advanced intermediate according to American Council on the Teaching of Foreign Language guidelines) classroom settings. After subtracting students who were native speakers of Spanish or whose parents were native speakers, as well as students who missed a test and/or a day or more of class activities, there were 43 subjects in level IV. None of these students scored higher than 65% on the pre-test. They ranged in age from 15 through 17 years and attended a public high school in Minnesota. There was a conglomerate sampling; each of the three experimental groups was made up of an entire class.

The second part of the study included 27 students in Spanish III (intermediate level). Neither they nor their parents were native speakers of Spanish, and they were in attendance during all of the in-class activi-

ties and on test days. As was true of the participants in level IV, the two groups of Spanish III students were made up of intact classes. They attended a private college preparatory school in Minnesota, and they ranged in age from 14 to 18.

Materials

The materials used in this study included: a) the structured input activities used in processing instruction; b) meaning-based production or output activities that were used by three of the five groups; and c) a pre-test, an immediate post-test, and a second post-test given one week after the immediate post-test.

Structured input activities require the learner to focus on meaning. Meaning is of central importance, the target structures need to be located at the beginning of the sentence or phrase in which the students see or hear them, and any redundant lexical information is left out so that students have to process the form to understand the meaning and, therefore, to complete the activity. Students have to do something with the input. The activities include both oral and written components. The learners' natural processing strategies need to be taken into account when designing structured input activities.[2]

The two types of structured input activities are referential and affective activities. Referential activities have correct and incorrect answers. The referential activities guide the learner as he begins to acquire a linguistic element, and the affective activities reinforce the new processing strategies.

Example 1 is a referential activity used in these studies.

1. Choose the correct meaning of the sentence in italics.
Para que recoja su maleta, vamos al aeropuerto.
    a. *We go to the airport to pick up his suitcase.
    b. We go to the airport so that he can pick up his suitcase.

Affective activities are different than referential activities because all answers are possible. They still follow the basic rules and principles described above. Example 2 shows an affective activity.

2. Your family is going to host an exchange student! Mark the sentences that you think best describe your family in this situation. After marking them, compare your answers with those of a classmate.

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[2] This is a brief summary of the guidelines to follow when designing the structured input activities that aid in the resetting of parameters. See VanPatten (2004) and Wong (2004) for a complete discussion of the guidelines of PI and the principles of input processing.

We are going to have an exchange student...
_____ ...to learn about a new culture.
_____ ...before I graduate.
_____ ...without asking my brother what he thinks.
_____ ...so that he/she can learn about our culture.

Every effort was made to design activities that would be of interest to the students while obeying the guidelines described above.

Production activities

The production activities were carried out in pairs. One activity was oral; the students were given a context, and each was assigned a role. They were directed to converse, using the target structures and four distractor items. Another activity included a series of drawings. Students wrote a narration of what occurred in the drawings, using the six target structures plus two distractor items. Students had to concentrate on meaning at all times, thus some authors might refer to this portion of the experiment as meaning-based output instruction.

Tests

Each of the tests included three sections to see whether the students were capable of identifying the structures correctly and two sections in which students had to produce the structures.[3] Results were initially divided by interpretation and production scores (Kirk, forthcoming) because production abilities often lag behind comprehension.[4] All participants were allowed up to 25 minutes to complete each test.

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[3] The first section of each test included ten multiple choice questions, six of which included the target structures; there were four distractor items. The second section included six drawings (one per target structure). Beside each drawing were two sentences. The students had to identify which sentence described the statement. The third section included a short reading, followed by a word bank including the target structures and four distractor items. The students had to choose the correct word(s) to complete each sentence according to what they had just read. The final two sections of each test measured the ability of the students to produce the structures. In one section, they had to translate ten sentences (six target structures and four distractors) from English to Spanish. In the other section, they had to write a dialogue, using the target structures and four distractors.

[4] Results correlated with those of many other studies in that PI seemed to be a useful tool with which to teach the structures. The results of PI were equal to those of PI and output together as long as more time was devoted to PI than to output. Dedicating more time to output than to PI resulted in lower scores, although not always significantly so.

Procedure

Students in the advanced intermediate Spanish classes (level IV) were divided, by class section, into three experimental groups. The first received processing instruction three days in a row (PI + PI + PI). There were 14 students in this first group. The second group of students in Spanish IV included 16 students. They received PI two days and then output practice the third (PI + PI + O). A third group, made of up of 13 students, did all of the same activities as the second group, but in a different order (PI + O + PI).

There were two groups of Spanish III students. The procedure followed by the first group, which included 13 students, was the same as that of the first group in level IV. Their activities included three days of processing instruction in a row (PI + PI + PI). There were 14 level III students in the second group. Their activities included PI one day, followed by two days of meaning-based output practice (PI + O + O). This final group was the only group to dedicate more time to output instruction than to the structured input activities of PI.

One week after the pre-test, the in-class instruction began. On day one, students received 10–15 minutes of explicit information, in which they were presented an explanation about how the structures work in Spanish and how they differ in Spanish (the students' second language) differ from those in English, the students' first language. After that explanation, students carried out approximately 30 minutes of structured input activities. There were approximately 30 minutes of instruction each of the two following days as well. Upon completing the activities on the third day, the students completed the immediate post-test. They were surprised with another post-test one week later.

Scoring

The students received one point each time they correctly identified or used each structure on any of the tests. Since there were five sections on each test and each section included one example of each target structure (e.g., *para + infinitive, antes de que + subjunctive*), the maximum possible score for each structure was five points.[5]

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[5] The three interpretation sections were multiple choice or fill in the blank. On those as well as on each of the two production sections, the students had to take into account whether there was a change of subject in each sentence. If there was a subject change, students had to use the correct structure with the subjunctive. The sentences without a change of subject required the infinitive. No points were taken off for errors relating to subject/verb agreement, spelling, or for errors relating to the sequence of tenses. If students used the wrong word (e.g., the sentence required para and the student wrote antes

Results

Level IV

Because the sample size was small and because the maximum score of five correct answers for each structure on each test was also a low number, there were very few statistical differences between groups. However, the graphs included here demonstrate some interesting similarities and differences.

The results of the advanced intermediate students on the structures with *para* and *para que* show that the participants in the PI + PI + PI group continued to advance in the ability to interpret and produce the structures even after the immediate post-test (Fig. 1). The graphs indicate group averages.
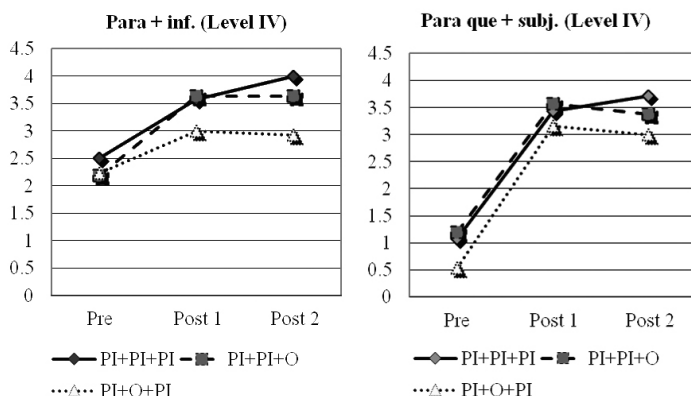
Fig. 1. Level IV. *Para + inf.* (left); *para que + subj.* (right)

The results with *antes de + infinitive* and *antes de que + subjunctive,* like those of *para* and *para que,* demonstrate similarities between groups (Fig. 2). It is worthy of note that the students made less dramatic improvement on the structure that requires infinitive than they did on the one with subjunctive, showing that the structure *antes de + infinitive* is a stubborn one.

de), or if they used the incorrect structure (e.g., if the sentence required para + infinitive but the student used para que + subjunctive), no point was awarded.
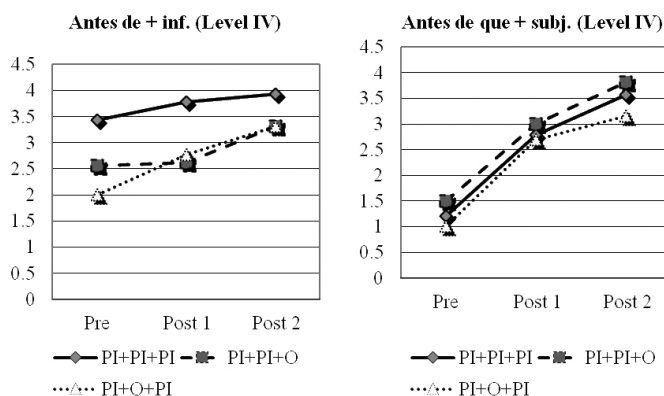
Fig. 2. Level IV. *Antes de + inf.* (left); *antes de que + subj.* (right)

The immediate post-test results show that the PI + O + PI group did not learn the structure *sin + infinitive* as rapidly as the other two groups (Fig. 3, left); however, this group gained ground and nearly reached the same level as the other two groups in the second post-test. This difference seems to point to the fact that "comprehensible input" at the beginning of instruction (received earlier in a greater quantity by the groups PI + PI + PI and PI + PI + O) seems to implicate faster acquisition. However, their results were equal to those of the other groups in the long term.
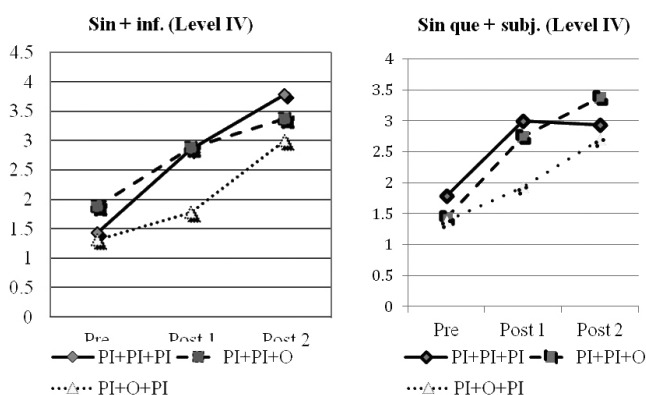
Fig. 3. Level IV. *Sin + inf.* (left); *sin que + subj.* (right)

The results of *sin que + subjunctive* (Fig. 3, right) demonstrate a similar phenomenon. The PI + O + PI group's acquisition seems somewhat delayed, but in the long run they catch up to the other groups. The results from the groups in level IV seem to indicate that some structures may be more resistant to acquisition than others.

Level III

Although the results of the PI + PI + PI group in level III resemble those of the PI + PI + PI group in level IV, the less advanced group did not attain the same level of acquisition. The results of the participants in level III show a more typical curve than those of the students in level IV. Figure 4 shows that the PI + PI + PI group improved markedly from pre-test to immediate post-test, but their scores diminished again before the delayed post-test. Both groups in level III demonstrate a similar curve. However, there is a definite difference in the two groups' results regarding *para que + subjunctive*. The first group (PI + PI + PI) improved noticeably more than the group whose instruction devoted more time to meaning-based output instruction than to processing instruction (PI + O + O).
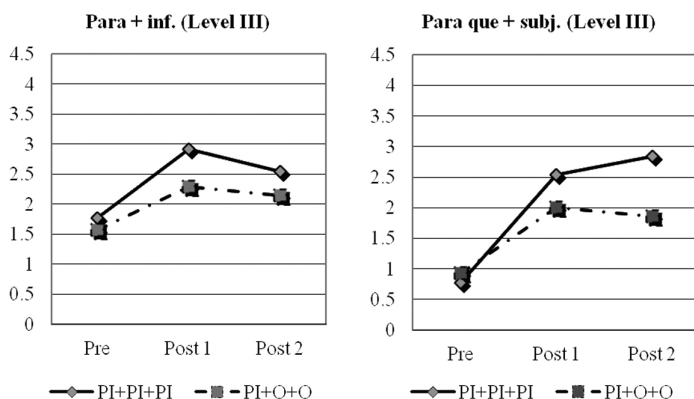
Fig. 4. Level III. Para + inf. (left); para que + subj. (right)

When acquiring the structure *antes de + infinitive,* the first group (PI + PI + PI) again continued to improve even after the end of the instruction. The PI + O + O group advanced very little and then experienced a decline to a point even below their pre-test scores on the second post-test (Fig. 5). The results for the structure *antes de que +*

subjunctive (Fig. 5) demonstrate that the participants who acquired the structure through PI alone had better and longer-lasting results than the students who dedicated more time to output instruction than to PI.
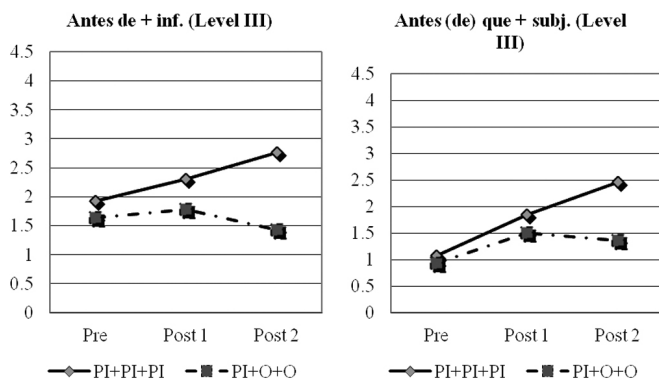
Fig. 5. Level III. *Antes de + inf.* (left); *antes de que + subj.* (right)

Sin + infinitive is the only example where the PI + O + O group advanced from the first post-test to the second, and the only one in which it advanced more than the PI + PI + PI group (Fig. 6, left). That said, the two groups' progress with the structure in the long run shows that both groups improved on the structure *sin que + subjunctive*, but that the PI + PI + PI group had longer-lasting and superior results (Fig. 6, right).
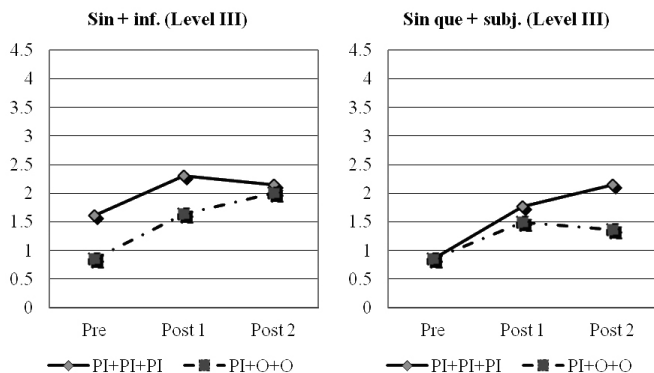
Fig. 6. Level III. *Sin + inf.* (left); *sin que + subj.* (right)

The results of the groups in level III suggest the same acquisition order of the different structures as the order noted in level IV. It is easier to note the outcome when viewing the results of all of the groups together, including students in both levels III and IV. Of the structures with infinitive (Fig. 7, left), *para* seemed the most easily acquired, while students progressed least with *antes de.* Of the structures with subjunctive (Fig. 7, right), students undoubtedly acquired *para que* more rapidly than the other two structures with the subjunctive; *sin que* seemed to cause the greatest amount of difficulty by a slight margin. This order is established by the fact that students progressed most with the structure with *para que*, and least with *sin que.* Possible explanations for this hierarchy of difficulty, including syntactic complexity, comparative grammar, and frequency of use, will be examined in a future article.
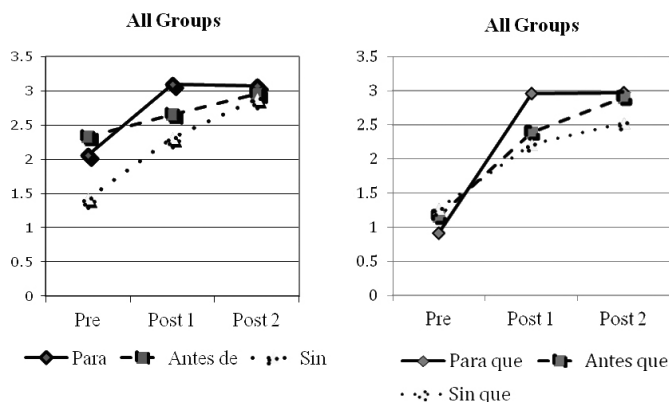
Fig. 7. Levels III and IV results; infinitive (left); subjunctive (right)

Because of a lack of space and in spite of the desire to include the scores of all individual students, only group averages are represented in the Appendix.

Conclusion and Discussion

This study makes one completely new contribution to the field of second language acquisition: there seems to be a hierarchy of difficulty in the structures studied here. The study also reiterates that PI is a useful tool, that the provision of meaning-based output does not seem to enhance the effects of PI, and that intermediate and advanced-

intermediate learners at the secondary level can acquire these structures, although to different degrees.

The following conclusions can be drawn regarding the central questions of this experiment. First, it seems that some structures included in this study are more easily acquired than others. Second, we can establish an order of difficulty among the structures included; it appears that, of the infinitival structures, the order of difficulty is *para < sin < antes de*. Of the structures that require the subjunctive, the order appears to be *para que < antes (de) que < sin que.*]

Limitations

The study described here has one main limitation: small numbers. Since the sample sizes were small, it was harder to find significant differences between groups. That small number was aggravated by an even greater limitation: the low number of possible correct answers for each structure included on the tests. In spite of these limitations, the findings suggest interesting trends that may be further validated with future, large-scale studies.

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Appendix

Table 1: Average scores by group and grammatical structure									
Level IV	**Para + inf.**			**Antes de + inf.**			**Sin + inf.**		
	Pre-test	Post 1	Post 2	Pre-test	Post 1	Post 2	Pre-test	Post 1	Post 2
PI+PI+PI	2.50	3.57	4.00	3.43	3.79	3.93	1.43	2.86	3.79
PI+PI+O	2.19	3.63	3.63	2.56	2.63	3.31	1.88	2.88	3.38
PI+O+PI	2.23	3.00	2.92	2.00	2.77	3.31	1.31	1.77	3.00
	Para que + subj.			**Antes de que + subj.**			**Sin que + subj.**		
PI+PI+PI	1.07	3.43	3.71	1.21	2.79	3.57	1.79	3.00	2.93
PI+PI+O	1.19	3.56	3.38	1.50	3.00	3.81	1.44	2.75	3.38
PI+O+PI	0.54	3.15	3.00	1.00	2.69	3.15	1.38	1.92	2.69
Level III	**Para + inf.**			**Antes de + inf.**			**Sin + inf.**		
PI+PI+PI	1.69	2.92	2.62	1.92	2.31	2.77	1.62	2.31	2.15
PI+O+O	1.57	2.29	2.14	1.64	1.79	1.43	0.86	1.64	2.00
	Para que + subj.			**Antes de que + subj.**			**Sin que + inf.**		
PI+PI+PI	0.77	2.54	2.85	1.08	1.85	2.46	0.85	1.77	2.15
PI+O+O	0.93	2.00	1.86	0.93	1.50	1.36	0.86	1.50	1.36

Shaw's Super(wo)man: Joan of Arc and Modern Saints' Plays

Jennifer Large Seagrave
University of Utah

Abstract

When George Bernard Shaw wrote Saint Joan*, his modern saint's play about the life and martyrdom of Joan of Arc, he attempted to reveal an authentic Joan of Arc, whom he believed had been mythologized by the Catholic Church as well as the many dramatists who have depicted her. In presenting her as a heretic whose faith in her own visions led her to deny the guidance of the Church, Shaw depicts Joan as the Superman (or Superwoman) he describes in his essays: able to see past the norms of her own day to guide humanity to a future that lies beyond. In the resulting play, Shaw employs a modern dramaturgy that evolves the medieval, church centered genre of saints' plays into a subversive form that challenges the Church itself.*

> When the Church Militant behaves as if it were already the Church Tri-
> umphant, it makes these appalling blunders about Joan and Bruno and
> Galileo and the rest which make it so difficult for a Freethinker to join
> it; and a Church which has no place for Freethinkers: nay, which does
> not inculcate and encourage freethinking with a complete belief that
> thought, when really free, must by its own law take the path that leads
> to The Church's bosom, not only has no future in modern culture, but
> obviously has no faith in the valid science of its own tenets, and is
> guilty of the heresy that theology and science are two different and op-
> posite impulses, rivals for human allegiance.
> —G .B. Shaw, The Preface to *Saint Joan*, "Catholicism not yet Catho-
> lic Enough"

No other group of plays invigorated or redefined modern saints'
plays more than those written in the 1920s depicting Joan of Arc. The
reason for this is clear: While Joan had been dramatized in every era
since her death, she was not canonized until 1920. The works of Shake-
speare, Voltaire, Schiller, France, and Twain revered and reviled a reli-
gious and nationalist zealot, not a saint. When the Catholic Church
completed the reversal of Joan of Arc's 1431 excommunication, canon-
izing her in 1920, the genre of modern saints' plays, including works
by Flaubert, Wilde, and Maeterlinck, got a proverbial shot in the arm,
spurring hundreds of representations in twentieth- and twenty-first-
century literature. Joan of Arc has remained one of the most varied and
enduring figures of the Western literary imagination since she was first
dramatized by Gilles de Rais just seven years after her death: She has
been the conjuring witch, condemned heretic, girl soldier, virgin savior,
national heroine, and patron saint of France. In 1920, two dramatic tra-
ditions that had lived separately since the fifteenth century converged—
that of secular plays on Joan of Arc and that of saints' plays.

To understand the union of modern saints' plays and representa-
tions of Joan of Arc in Shaw's *Saint Joan*, one must first look not only
to the historical character of both traditions but to the Shavism in which
the play arose. The saint's play tradition features the works, antics, and
(often posthumous) miracles of canonized saints whose personalities
are associated with particular causes and predicaments. Reflecting the
tales told in Voragine's *Golden Legend*, these plays valorized the
saints, making inspiring religious and moral superheroes of them.

As medieval saints' plays hyperbolize the acts and characters of
saints, plays about Joan of Arc also tend to depict her at extremes: As
Louis Crompton puts it, they "fit clearly into one or the other of the
infidel or fideist traditions" (33). These categories separate works on
Joan into camps that either reject or affirm the veracity of her spiritual-
ity. The most notable "infidel" works include "La Pucelle," a poem by

Voltaire (1730) that ends with her marriage to Dunois rather than burning at the stake, and "The Life of Joan of Arc," a biography by Anatole France (1908). These works react largely to the fervor of "miracle-mongering" in the eighteenth century and the popular rehabilitation of Joan as spiritual hero that occurred when the modern translation of her annulment trial was published in the mid nineteenth century. Acting in accordance with local anti-French sentiment, Shakespeare's portrayal of Joan in *Henry VI, Part I* rehearses Holinshed's *Chronicles*, portraying her villainously as a slut and witch.[1] Shakespeare's work is not technically "infidel" since he does give credit to her spiritual power—her diabolical spiritual power.

> Richard Plantagenet (Duke of Gloucester):
>> Strumpet, thy words condemn thy brat and thee:
>> Use no entreaty, for it is in vain.
> Joan la Pucelle:
>> Then lead me hence; with whom I leave my curse:
>> May never glorious sun reflex his beams
>> Upon the country where you make abode;
>> But darkness and the gloomy shade of death
>> Environ you, till mischief and despair
>> Drive you to break your necks or hang yourselves!
> [Exit, guarded]
> Richard Plantagenet (Duke of Gloucester):
>> Break thou in pieces and consume to ashes,
>> Thou foul accursed minister of hell!

Here Shakespeare's Joan, caught in lies and curses, embodies a hellish witch who conjured demons to help win the battle of Orleans and who even denies her own virtue, claiming to be carrying a child belonging alternately to the French General and the King of Naples. Contrastingly, Schiller's Joan in *The Maid of Orleans* (1801), as virgin as Shakespeare's depiction is wanton, actually dies on the battlefield, having subjugated her romantic love of a particular English soldier for the moral love of her country. Continuing in the fideist tradition after 1841, when Quicherat published transcripts of the annulment trial, Mark Twain penned his version of Joan in both a short biographical essay and a fictional biography called *Personal Recollections of Joan*

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[1] For a more detailed account of works on Joan of Arc that influenced Shaw, see Crompton's article, "A Hagiography of Creative Evolution." For a surprisingly complete list of works on Joan of Arc, see the Wikipedia entry for "Cultural Depictions of Joan of Arc" at http://en.wikipedia.org/wiki/ Cultural_depictions_of_Joan_of_Arc (Accessed October 18, 2012).

of Arc (1896). Twain so adored Joan that he claimed he found "no blemish in that rounded and beautiful character" and gave a public speech in her honor, exhorting "the divine soul, the pure character, the supreme woman, the wonderful girl" (Ryan).

Eschewing the specific religious affiliations of Joan of Arc and instead emphasizing her vigor in pursuing a kind of "Holy War" against patriarchy, the women's movement in England, and later in the U.S., adopted the image of Joan as an emblem (National Women's History Museum). She inspired a "divinely sanctioned militancy," giving women's protests a historical leader to rally behind. Her image appeared the cover of England's Women's Social and Political Union's *Suffragette* magazine, adorned flags to be used as banners in political marches, and inspired women to ride in full armor on horseback in both England and America. Joan represented a vigorous anti-patriarchal struggle before her canonization in 1920, which brought with it complications for the fight against institutional discrimination (Sillup).

Shaw's portrayal of the saint as a super(wo)man does not stray far from her crusading feminist precedent, but it does bring a new critical dimension to saints' plays, which typically portrayed the popular folk versions of the saints' feats. Rather than infidel or fideist, Shaw's conception of Joan defies the contrast, as his Saint Joan loves God and the church but bases her decisions on the personal judgment she makes in the wake of revelations from her "voices." Although his character attributes the voices to saints interceding for God, Shaw provides no transcendent verification of this claim. He is clearly skeptical of the veracity of Joan's claims but does not allow the questionable source of her personal judgment to nullify its significance or the heroic virtue of her character. In this way, he subverts the supposition of true religiosity inherent in saints' plays as well as refuses to take sides in the fideist–infidel controversy. In fact, Shaw demystifies Joan to a point at which she might be judged by her actions alone.[2]

In the Preface, Shaw holds that because we judge human sanity not by the *method* that brings visions or voices but by the *messages* they convey, we must judge Joan (as we do Newton and Saint Catherine) to be sane. He writes that her voices "never gave her any advice that might not have come to her from her mother wit exactly as gravitation came to Newton," and thus she is no more insane. His argument,

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[2] This judgment "by works alone" bears direct contrast to the Protestant tenet of Martin Luther that humans will find justification by their faith alone—human works being insufficient to justify salvation through Christ's sacrifice. The contrast here sheds light on the highly secular version of ideal "Protestantism" Shaw advocates in the Preface, which will be discussed later in this chapter.

nevertheless, suggests that if the same method had brought her a less "sane" message, she would have been insane, there being no difference but the message. The weight of this analysis assigns credit for Joan's visions to her own psyche and away from divine power. In the same year Shaw wrote *Saint Joan*, a physician named Charles MacLaurin wrote that Joan's voices derived "as a delusional compensation for the girl's failure to develop sexually" (Sanders 207). Noting his awareness of such pronouncements, Shaw writes in the preface that Joan's voices "have been held to prove that she was mad, that she was a liar and impostor, that she was a sorceress (she was burned for this), and finally that she was a saint." Shaw's definition of "saint" rests with ambiguity about the origin of the voices that led Joan to act as she does. What defines the saint as opposed to the superman, per se, is the message and action produced and the Church's determination of them as defending the faith or not. In Joan's case, the Church found Joan's actions first to be heresy and later to be saintly. Shaw's discrepancy with the Church stems from his understanding that the initial ecclesiastic court judged Joan correctly as proffering a heretical message. The Church condemned this court for corruption while Shaw claims that in order to validate the coronation of Charles, they changed their mind about the origin of Joan's voices. For the Church, saintliness relies on the origin of saintly inspiration, while for Shaw, saintliness relies on the progressive nature of the revelation and the saint's willingness to see it through to the end. Canonization exists only as the religious and legal acknowledgement of the saint. This secular understanding of saintliness as a form of progressive heroism allows Shaw to admire Joan as a super(wo)man and write her character in a positive light outside the fideist/infidel conventions of Joan of Arc literature.

Although hyperbolic exaggerations of saint's miracles and abilities were typical of medieval saints' plays, such exaggerations were hardly conventional in the theatrical naturalism and realism that rose to prominence in the nineteenth century, bringing with them a modernist practice of uncovering the plight of real lives. As these plays realize the confining circumstances of wives and reveal the sins of fathers,[3] they criticize idealized institutions, like marriage. Similarly, modern saints' plays of the realistic theater in the early twentieth century work not only to demystify saints as subjects, but some work to criticize the Church as well. In the wake of Ibsen's realism, Shaw wrote plays for

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[3] As in Ibsen's *A Doll's House* and *Ghosts*, respectively.

the realist stage,[4] employing character-driven dialogue in three-wall surroundings. While humorous, ironic, and satirical, Shaw's dramatic force owes much to Ibsen's realism. Reacting to the plethora of what he believed to be misrepresentations of Joan throughout history,[5] Shaw notes that MacKaye's 1906 heroine in *Joan D'Arc* was "'pitiable, sentimental, and in the technical melodramatic sense, sympathetic,' and about as much like Joan 'as Joan's kitten was like Joan's charger'" (Crompton 35). So, combining the concept of the shunned hero and his own conception of Joan as a progressive super(wo)man, Shaw had his say on stages in New York and London in 1923.

In "The Quintessence of Ibsenism," Shaw describes his concept of the shunned hero, illustrated best in Ibsen's *An Enemy of the People*. At the end of Act I, having discovered proof of contamination in a water supply that would fill a new town bath, Ibsen's protagonist, Dr. Stockmann, exclaims, "I feel tremendously happy! It is a splendid thing for a man to be able to feel that he has done a service to his native town and to his fellow-citizens" (Act I). The discovery allows the protagonist to fulfill his role as town protector, as the scientist whose craft would save the populace from disease. In such a role, Dr. Stockmann struggles in honesty on the town's behalf, exhibiting a traditional, moral imperative: protecting people from certain physical harm. The ideally favorable aspect of his actions creates ironic tension as the townspeople gradually turn violently against him, attack him for stunting their commercial enterprise, and destroy his life.

The shunned hero who upholds the traditional morality of the people who denounce or exile him appears throughout literature from Plato to the *Bible* to Maeterlinck's 1904 *Miracle of St. Anthony*. Stockmann's final words in Ibsen's play distill the concept: "the strongest man in the world is he who stands most alone"—strength is often defined by those who remain faithful when all turn against them. Likewise, Shaw's Joan stands alone, unable to get through to her "society." As Obraztsova explains in "A People's Heroine," Shaw "summed up the results of his many years of reflection about a particular type of realist" in Joan. In her, Shaw incorporates "his own enormous faith in the reason and strength of man, while honestly recognizing that what even the strongest and most intelligent person can do alone is insufficient in order to change society" (220). And while this image of the exiled hero provides a basis for Shaw's *Saint Joan*, in "The Quintes-

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[4] As Martz puts it, "Shaw is writing, as he and Ibsen had to write, within the conventions of the modern realistic theater—conventions which Eliot escaped in Murder in the Cathedral because he was writing this play for performance at the Canterbury Festival" (153).
[5] He makes this extremely clear in the Preface to *Saint Joan*.

sence of Ibsenism" Shaw reveals the extra weight of his own expectations for a superhero: that her ideas must exceed traditional moral character and look toward something entirely new.

Shaw's Joan must not, as Ibsen's Stockmann and Maeterlinck's St. Anthony do, hold steadfast to society's moral ideal. She must hold up something else—something unheard of, and even scandalous. As Brown puts it, "The Shavian hero lives by a higher ethic, unencumbered by traditional values and outdated moral codes (Brown, "Shaw" para. 10). The break with traditional moral codes as a point of heroism characterizes Shaw's concept both of the superman and of "Protestantism." In *The Perfect Wagnerite*, he describes his concept of "Protestantism" like this:

> Four hundred years ago, when belief in God and in revelation was general throughout Europe, a similar wave of thought led the strongest-hearted peoples to affirm that every man's private judgment was a more trustworthy interpreter of God and revelation than the Church. This was called Protestantism; and though the Protestants were not strong enough for their creed, and soon set up a Church of their own, yet the movement, on the whole, has justified the direction it took. Nowadays the supernatural element in Protestantism has perished... (Siegfried as Protestant para. 2)

Thus, for Shaw, the category of "Protestant" lies not with any specific church or dogma but in the affirmation of private judgment over institutional dogma. It echoes the ideals of Martin Luther, whose proliferation of the concept of "justification by faith alone," rather than conformity with Pope or Church, redefined Christianity in the fifteenth century. It concerns an attitude of steadfast faith in one's private revelations from God in conflict with accepted moral codes or Church teachings. While Shaw does refer to a specific, contemporary institution as "Protestantism," it is clear that he considers the concept and the institution two separate things. As he wrote, "The Protestants were not strong enough for their creed … the supernatural element in Protestantism has perished." Therefore, and confusingly so, the Protestant Church, which might be interpreted as high-church Anglicanism, Lutheranism, or any other such institutionalized non-Catholic Christian denomination, is no longer characterized by what Shaw's concept of "Protestantism."

Illustrating his impression of Joan as a "Protestant" in a letter to Henry S. Salt, on July 16, 1923, Shaw wrote that Joan of Arc "warned the priest who was holding up the cross to her at the stake that if he did not jump down he would be burnt. [She was] quite a good humanitarian, and an early advocate of rational dress" (Laurence 843). He also notes that he mentioned her to G.K. Chesterton, whose very public

conversion to the Catholic Church had recently been completed. Shaw notes that the mention of Joan "elicited an outburst of rabid Protestantism from him," no doubt referring to Chesterton's confirmation of her virtuous martyrdom. Agreeing that Joan's loyalty to her voices in opposition to the ecclesiastic court constituted heroic virtue ironically favors the Protestant value of private judgment over the governance of Catholic leadership. Shaw goes on to claim, "Joan was burnt, quite correctly, for being a Protestant before the name was invented" (843). Humanitarian, advocate of rational dress, and Protestant—these are the characteristics Shaw sees in Joan. Not a supplicant virgin, not a pastoral beauty or a harlot-witch, but a shrewd, capable individual of extraordinary will, like John Tanner, the hero of his earlier work *Man and Superman*.

Drawing the saint as his own version of a super(wo)man, Shaw depicts Saint Joan as an innovator for whom the world is not ready. In *The Sanity of Art* he remarks, "We cannot ask the superman simply to add a higher set of virtues to bend respectable morals, for he is undoubtedly going to empty a good deal of respectable morality out like so much dirty water and replace it by new and strange customs, shedding old obligations and accepting new and heavier ones" (288). He acknowledges that the "respectable morality" of man will appear to him as unnecessary refuse (288), as do the peerage and the intercession of the Church to Joan. Shaw writes that "The superman will certainly come as a thief in the night, and be shot accordingly" (288), as Joan is. For Shaw, she realizes a new consciousness beyond conventional morality that will elevate humanity to a more meaningful existence—in this case in direct communication with saints, the king, and God Himself. Joan moves beyond the station given her class and sex, crowning a king and defending a nation. In her defiance of the Bishop of Beauvais, the Earl of Warwick, and the Office of the Inquisition, she clings to the truth of her "voices," for which Shaw names her the first Protestant.

Shaw's character does not merely champion the pitiable, moral cause of protecting people as Ibsen's Stockmann did. She champions a cause that her King and fellow French officers do not recognize—she champions something no one else hears: the commands of her voices to fight for the freedom of France. She acts in a way she deems in accordance with her God, not her better, not her bishop. She dresses in a way that defends her virtue, not a way that reflects the moral ideals of her contemporaries. In short, Shaw's Joan is a heretic, through and through. As such, she is a superhero, a super(wo)man, and necessarily guilty of heresy. Her status as heretic contributes to Shaw's definition of saint—she is progressive, steadfast to her private revelation of the will of God, and able to accomplish great deeds.

In a modern interpretation of saintliness, Shaw defends the heretic as saint—a forward-thinking pioneer, "the man who declares that it is right to do something hitherto regarded as infamous," and who is "stoned and shrieked at by the whole army." He writes, "They call him all manner of opprobrious names; grudge him his bare bread and water; and secretly adore him as their savior from utter despair" (*Major Critical Essays*, 13). Here, Shaw reveals what he sees as a deep ambivalence in humans that propels them to cast out the non-conformist and secretly to venerate him. Unlike Dr. Stockmann, who is respected, feared, and shunned for his steadfast adherence to traditional morality, the Shavian super(wo)man, is shunned for the outrageousness of her claim that God has commanded her in her actions, which becomes the stimulus for her adoration only 24 years after her death. Joan of Arc's faithfulness to her voices, which reveal what she considers to be the will of God to her, constitutes the "Protestant" heresy for which she is martyred in Shaw's play and the heroism for which she is rehabilitated.

Joan embodies Shaw's concept of super(wo)man because she is condemned by the Church for her heresy, which is revealed actually to be brilliance as well as the vehicle for her rehabilitation and veneration. She becomes the subject around which he writes this play, exposing the willingness of the Catholic Church to admit "private judgment" outside its traditional dogma.[6] Ironically, Shaw endeavors to illustrate that the Catholic Church is more willing to admit private judgment than the Protestant Church, which was founded on the principle. He uses Joan, whom he calls "The first Protestant and the first Nationalist" to reveal this aspect of Catholicism (Laurence 795).

In a letter to Rev. Joseph Leonard in December, 1922, Shaw told his friend about his plans for writing *Saint Joan*:

> One of my missions in life is to make the Catholic Church conscious that it is more tolerant of private judgment than the Protestant persuasion, and to make the Protestant persuasion ashamed (if possible) of imagining that it grants a right of private judgment when it always attaches the condition that the private theologian must come to the same conclusion as his prayerbook." (Laurence, 798)

This "private judgment" about which Shaw writes concerns the ability of people to act in ways they personally deem to be in accor-

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[6] Shaw devotes a section of the Preface to explaining the fact that occasionally the church may amend its prior condemnation of a heretic (like Galileo or Bruno), granting the personal judgment as honorable and admitting a mistake—admitting that its own original judgment was not inspired of God, but of a fallible human.

dance with the Will of God outside the doctrinal contract binding the rest of the faithful. And if the Church recognizes (even canonizes) one person whose faith led her outside of orthodoxy, then the Church admits its fallibility, at least as regards that person. He explains in the Preface of *Saint Joan*,

> Thus, as revelation may come by way of an enlightenment of the private judgment no less than by the words of a celestial personage appearing in a vision, a saint may be defined as a person of heroic virtue whose private judgment is privileged. Many innovating saints, notably Francis and Clare, have been in conflict with the Church during their lives, and have thus raised the question whether they were heretics or saints. Francis might have gone to the stake had he lived longer. It is therefore by no means impossible for a person to be excommunicated as a heretic, and on further consideration canonized as a saint. Excommunication by a provincial ecclesiastical court is not one of the acts for which the Church claims infallibility.[7]

For Shaw, an admission of personal judgment acts as a proverbial chink in the armor of Catholic orthodoxy, providing a possibility for evolution and diversity. And the most revolutionary part of Shaw's observations in the Preface of *Saint Joan* is that the Catholic Church might recognize that God's unique revelation to an individual surely indicates God's ability to draw a new covenant with *any* individual. For Shaw, then, the just conviction of Joan by a legal court of the Church is imperative—she must actually have been acting in a way denounced by church doctrine but championed by her private revelation in order to be a true superhero. If he shows that Joan's voices directed her outside traditional doctrine to act in true heresy for which the court was bound to find her guilty, he can expose a famous admission of personal judgment legitimized by the Catholic Church when it rehabilitated and canonized her. This admission would fulfill his desire to enlighten Catholics about their own doctrinal ambivalence, shame the stringency of Anglican Protestant doctrine, and affirm his own modern (and possibly secular) interpretation of saintliness at the same time.

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[7] The issue of infallibility in the Church was defined at the Vatican Council of 1868. How versed Shaw was in the actual dogmatic definition is not clear, but his notes do show that he was aware that only certain pronouncements of doctrine concerning faith and morals are held to be "ex cathedra" or infallible, according to his apostolic succession. The quotation notes that there is no infallible authority granted to a provisional ecclesiastical court, which may rule a person a heretic and excommunicate her, allowing the public to put her to death.

Situated as he was within the confines of realistic theater, Shaw was compelled to make the content of his play factual, or, as Matrz has pointed out, to give it at least the "appearance of facts" (18). This aspect of modern saints' plays diverges greatly from the often fantastic content of Voragine's legends and plays like those devoted to the posthumous miracles of Saint Nicholas. Shaw's study of Joan's rehabilitation trial provided him with material for his play and evidence for his argument. In preparing to depict evidence that Joan was "condemned as a heretic, which she was" (Laurence 795), Shaw explains that he "took care to avoid the histories, and read the process and nothing but the process"[8] (Laurence 798). He makes his case for the real guilt of Joan in a second letter to Father Leonard[9] in which he challenges his reader:

> Imagine yourself a good Catholic in the Holy Roman Empire phase, and a strong Unionist, and an old gentleman with ordinary prejudices as to female propriety. You are confronted by a young woman under twenty, a rabid Sinn Feiner, who persists in wearing rational dress, or rather, dressing like a common soldier, who has had the audacity to crown a king in a cathedral as if she were the Pope and he Charlemagne, who insists that she has had visits from apparitions who told her to do these things, and who—crowning heresy!—has said again and again that she does not believe the Church's teaching that these apparitions are devils sent to tempt her to sin, and that (like a good Protestant) she considers these messages from God to herself of higher authority than the Church…And to all reproof and exhortation she is contumacious as the devil himself." (Laurence 799)

This vision of Joan, a vision prompted by what appears, at least in his letters, to be Shaw's actual understanding of Joan of Arc, constitutes the protagonist of *Saint Joan*. Quoting often from the trial notes, Shaw's play depicts that brilliant non-conformist of a super(wo)man, alternately shunned and admired. And, to accurately portray the heretical Protestantism for which he so admired her, Shaw had to depict a fair court to find her guilty of that heresy.

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[8] Which means that he confined his study to Murray's 1902 translation of Quicherat's proceedings of Joan's rehabilitation trial, in isolation.

[9] In the first letter he writes a version of the same story, but wholly without evidence. He even refers to Joan as having been canonized "In 1907 (I think)" (Laurence 795). His ignorance even of the decade of her canonization colors the veracity of his original narrative and seems to throw much doubt on his desire to come away from the actual transcript with anything but confirmation of the story he had already determined. As Shaw's contemporary Charles Sarolea puts it, "he reveals that deeper kind of ignorance of the writer who does not even know that he does not know" (95).

Shaw had an uphill battle on his hands as he prepared to show the court of Warwick and Cauchon, in a just light. While much of Joan's dialogue comes directly from the trial notes,[10] Shaw builds his case for Joan as heretic through fictitious dialogue between The Earl of Warwick (Warwick) and the Bishop of Beauvais (Cauchon) who describe her heresy against both church and state. Significantly, they summarize:

> CAUCHON. I see now that what is in your mind is not that this girl has never once mentioned The Church, and thinks only of God and herself, but that she has never once mentioned the peerage, and thinks only of the king and herself.
> WARWICK. Quite so. These two ideas of hers are the same idea at bottom. It goes deep, my lord. It is the protest of the individual soul against the interference of priest or peer between the private man and his God. I should call it Protestantism if I had to find a name for it. (Scene IV)

In a fascist-like description of a peerage-less king or priest-less God, the characters explain to one another their objection to Joan and their reasons for agreeing, "Well, if you will burn the Protestant, I will burn the Nationalist" (Scene IV). And yet Shaw takes pains to paint these two with moral character. They are not mercilessly out for Joan's blood as the English Chaplain, De Stogumber, is. The scene ends with their moral defense:

> WARWICK [rising]. My lord: we seem to be agreed.
> CAUCHON [rising also, but in protest]. I will not imperil my soul. I will uphold the justice of the Church. I will strive to the utmost for this woman's salvation.
> WARWICK. I am sorry for the poor girl. I hate these severities. I will spare her if I can.
> THE CHAPLAIN [implacably]. I would burn her with my own hands.
> CAUCHON [blessing him]. Sancta simplicitas!

Neither Warwick nor Cauchon, in Shaw's estimation, conspires to corrupt the court that would find Joan guilty.

While Joan's voice has been recovered in the transcripts of the annulment trial—a trial that ends with her restoration and the excommunication and desecration of Cauchon and Warwick—it is the voices of Cauchon, Warwick, and the Inquisitor that Shaw goes to great

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[10] See Tyson, *The Story of Shaw's Saint Joan*, for a detailed account of Shaw's study and use of the trial transcript.

lengths to legitimize in his play. At the start of her final examination, the three expose their desires to conduct a fair trial:

> WARWICK. …I tell you now plainly that her death is a political necessity, which I regret but cannot help. If the Church lets her go--
> CAUCHON [with fierce and menacing pride]. If the Church lets her go, woe to the man, were he the Emperor himself, who dares lay a finger on her! The Church is not subject to political necessity, my lord.
> THE INQUISITOR [interposing smoothly]. You need have no anxiety about the result, my lord. You have an invincible ally in the matter: one who is far more determined than you that she shall burn.
> WARWICK. And who is this very convenient partisan, may I ask?
> THE INQUISITOR. The Maid herself. Unless you put a gag in her mouth you cannot prevent her from convicting herself ten times over every time she opens it. (Scene VI)

These speeches, crafted by Shaw to legitimize the court that condemns Joan, may represent his actual understanding of the people themselves, or, as Daniel Gerould suggests, it may be that "Shaw cleverly put his philosophical ideas into the mouths of fully human characters," enabling his own method "of saying the opposite of what the public expects" (216). The lack of evidence for these conversations leads Martz to write, "There is no historical basis for his highly favorable characterizations of Cauchon and the Inquisitor" (153). Gerould agrees, "Shaw suppresses facts that show the trial to be a conspiracy in order to make Cauchon a more effective contrast to Joan" (216)—the contrast lies in Joan's Protestantism and Cauchon's Catholicism rather than the binary of saintliness and treachery an audience might expect.

In a Catholic court trying a Protestant, Shaw's Inquisitor and Cauchon must find Joan guilty of heresy, lest she lead souls of the faithful away from Christ's salvation. The Inquisitor's long speech in Scene VI illustrates his understanding of heresy as a sort of slippery slope ending in hell. He claims that all heresy "begins with people who are to all appearance better than their neighbors," but ends in "a monstrous horror of unnatural wickedness left unchecked." In defense of the Church's harsh dealing with heresy, the Inquisitor explains, "if you hate cruelty, remember that nothing is so cruel in its consequences as the toleration of heresy," referring specifically to the damnation of an increasing number of souls tainted by the original heretic. Thus, the Inquisitor believes his judgment, finding innocence or punishing guilt, works for the greater good of the souls of humanity. Defending the treatment of Joan by the court in the Preface, Shaw goes so far as to report that, "The truth is that Cauchon was threatened and insulted by the English for being too considerate to Joan," which is surprising given that he is

often accused of villainously condemning her despite his questionable jurisprudence in the case. Shaw's Cauchon tries multiple times to get Joan to deny her "voices," wear appropriate clothing, and come back into the fold of the church. But, as a good Shavian saint, Joan persists in her faithfulness until she briefly recants and relapses[11] before being condemned to the fire.

The fact of Joan's "Shavian sainthood" condemns her in the orthodox eyes of this play's court. Crompton describes the Shavian "Communion of Saints" in the style of Carlyle, consisting of mystical supermen[12] such as "Socrates and Mohamet," making it more like the inhabitants of the higher rings in Dante's *Inferno* than the Catholic Paradise[13] (36). This conception of saintliness includes what Stoppel explains as the "indefatigable labouring after success" that "derives its significance solely from a vitalistic conception of human progress and development" (Stoppel 181). Shaw, whose concept of saintliness outside the Catholic or Anglican Communion of Saints echoes James' concepts of universal saintliness outside of any specific faith, takes sainthood here into a secularized space. Saintliness no longer must relate to anything spiritual. He confirms in the preface that he regards Joan's voices as figments of her imagination, but not compromising her sanity. He insists that "her dramatic imagination played tricks with her senses," but it does "not prove that she was mad." Rather it shows that "she was none the less an able leader of men for imagining her ideas in this way" (Preface: "Joan's Voices and Visions"). Her saintliness, for Shaw, clearly lies in her martyrdom for the heroic values produced by her own "private judgment." Shaw sets his Joan up as the antithesis of Catholic orthodoxy and depicts the court as fair and even kind. In so doing, he clearly displays his own conviction to write his play in accordance with his original purpose: exposing the Church's admission of "personal judgment" by legitimizing Joan's conviction.

It bears noting that the Catholic Church does not view Joan of Arc as a heretic-turned-saint and has, in no uncertain terms, condemned the bias of Joan's original trial. This is significant because the condemnation of the court that found Joan guilty of heresy means that she never

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[11] Some readers make too much of this recanting. We have only to remember Peter's denial of Christ to find Biblical precedent for Joan's brief recantation and subsequent martyrdom.

[12] Stoppel's "Shaw and Sainthood" makes a case for Shaw's "saints" as constituted by both relentless striving for success in the progress of humanity and a sort of non-theological mysticism (183).

[13] Interestingly, Metro Books' (New York) 2011 encyclopedia of saints also includes such individuals as Gandhi and Martin Luther King, Jr.

was a heretic. And, what's more, Shaw knew this perfectly well. The letter he received from Father Leonard on December 14, 1922, told him as much, clearly refuting the veracity of Shaw's statements in the earlier letter that laid out his ideas about Joan, as of yet unconfirmed by his study of Quicherat or Murray (Laurence 797). In the online archive of Joan of Arc trial information, Allen Williamson provides, in detail, the evidence that Joan's relapse was certainly an issue of her re-donning male clothing to prevent rape, not insisting that she couldn't live in captivity, as Shaw's script suggests. This evidence is taken from the same transcript Shaw used as the basis for his script. One might draw the conclusion, then, that Shaw himself exhibits similar qualities to his own Saint Joan: He persists in remaining faithful to his own ideas for the progress of humanity in direct conflict with the judgment of the Church. Like his Inquisitor attempted to unveil heresies in maids' clothing, Shaw attempts to unveil truths about the "Law of Change" being the "Law of God" by exposing the admission of private judgment in the Catholic Church. He uses the conventions of Ibsen's realistic theater to give veracity to his own interpretation of Joan as a Protestant saint, whose heresy condemned her and likewise proved her sanctity.

Shaw claims in the Preface to *The Sanity of Art,* "I deal with all periods; but I never study any period but the present" (5). Clearly, in *Saint Joan* he employs the conventions of realistic theater to present a "history" that criticizes the Church of the present day. His personal definition of the saint as a progressive and mystical super(wo)man allows him to repurpose the Saint's Play tradition in a secular and critical form. Rather than mirror the cult of a saint as medieval Saints' Plays or inspire Catholic revival as Decadent Saints' Plays, modern saints' plays after the Great War became a tool for holding society up to itself and criticizing the institution responsible for canonization itself. In this way, *Saint Joan*, as a modern saint's play, co-opts the figure of Joan of Arc as well as the form of the Saint's Play in a subversive dramaturgy.

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Romancing Mathematics with Chemistry—How Mathematical Trees Can Be Used to Synthesize Molecular Structures

Chin-yah Yeh
Utah Valley University

Abstract

Structures of chemical compounds can be synthesized and categorized through mathematical means. Organic compounds are suitable targets because of their simple valences. Acyclic organic compounds made of hydrogen and second-row elements C, N, O, and F are presented as an example. In five categories of organic compounds, chemical structures can be generated exclusively and exhaustively using ab initio methods. It is shown that mathematical variables can serve as chemical symbols and mathematical equations are chemical structure generators.

I. Background

Chemists have a long tradition of using atomic valences to find molecular structures graphically. Chemistry relies on this simple procedure to make progress; however, drawing does not generate structures systematically, i.e., there is no guaranteed completeness or uniqueness. Are all structures generated? Is a structure generated more than once? Take butane molecules (C_4H_{10}) for instance. It can be seen (Fig. 1) that one straight-chain and one branched structure suffice. But as molecular size gets bigger, finding structures exhaustively and uniquely can become a daunting job. This paper deals with how we generate chemical structures from first principles. Compared with the empirical method that relies on computers,[1] structural generation through first principle has a long and winding past.
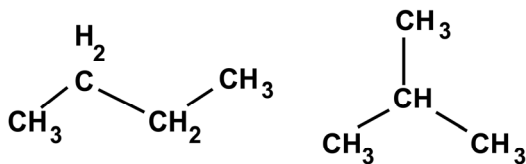
Fig. 1. Structures for butanes

About the time Darwin published his *Origin of Species*, two mathematicians endeavored in structuring chemical compounds. They are called the 'invariant twins,'[2] Sylvester and Cayley. Their idea was to start from two observations. First, certain algebraic equations do not vary under geometrical transformations (a circle does not vary under rotation around an axis through its center, for instance). Secondly, chemical structures and molecular properties do not vary under the same transformation either. What is the connection? Sylvester related chemical structures, as understood at his time, to invariant algebraic forms. The result was published[3] in 1878 but does not lead very far. Cayley[4] acknowledged Sylvester's effort and focused on simple acyclic structures. Cayley's invention of an analytical form called trees has proven to be the right tool for generating chemical structures, even though he used this analysis only for counting the structures.

II. Criticism and Potential of Cayley's Method

Cayley's result[5] caused numerous revisions shortly afterwards,[6,7] partly because of some errors found in his paper, as he used a manage-

able and yet laborious method that separates trees (which consist of lines and nodes) into centric and bicentric ones (Fig. 2). Nonetheless, what Cayley established should be seen as more of an analytical tool than a calculation. Some 70 years later, his method was proven rigorously by Otter[8] and generalized by Harary and Norman[9] (see Section IV). These authors improved Cayley's method by bypassing centric and bicentric trees. As a result, the method becomes harder to carry out manually, but easier to code (because of more repetitive steps; see Yeh[10] on coding). The present paper points out that Cayley and the above-mentioned authors have unknowingly (or unreportedly) discovered a mathematical tool for synthesizing a good part of the 10–20 million chemical compounds known today.

Fig. 2. Examples of (a) centric trees and (b) bicentric trees.

Inspired by Sylvester's work on the interchange of variables in differential calculus, Cayley[4] started the concept of mathematical trees. In modern terms, rooted trees are enumerated by the series expansion of a function $f(x)$ of an independent variable x as expressed in the equation

$$f(x) = xe^{f(x)}. \quad (1)$$

Then Otter's formula[8] $F(x) = f(x) - \frac{1}{2}\{[f(x)]^2 - f(x^2)\}$ is used to extract (or unlabel) root-free trees (see Fig. 3). Cayley did not limit the number of lines connecting to a node in a tree to four, but four happens to be the valence of a carbon atom in all organic compounds. We are able to adopt Cayley's scheme in organic compounds and include other essential atoms such as nitrogen, oxygen, and halogens. In Sections III and IV, we shall use Cayley's scheme on the simplest class of organic molecules, the alkane series (C_nH_{2n+2}), to illustrate two points. One is to show how his scheme complies with the concept of chemical structure, although he himself treated the alkane series differently—by counting centric and bicentric trees. The other is the central issue of this paper: Chemical elements can serve as mathematical variables and equations are generators of chemical formulas.
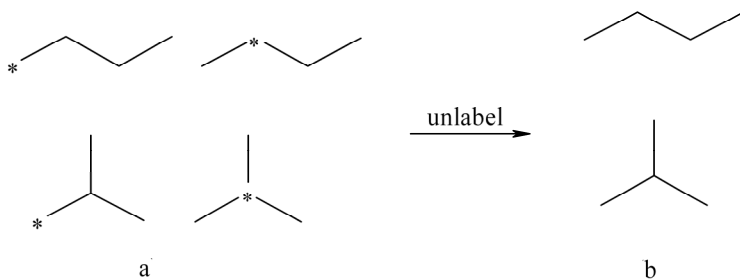
Fig. 3. Examples of roots in trees: (a) rooted; (b) root-free.

In essence, our instinct to draw does not quite work on chemical structures. The right strategy is to take a step back and find all rooted (labeled) structures first, as shown in Section III, and then unlabel them, as shown in Section IV.

III. Rooted Alkane Series (C_nH_{2n+2})

Nothing is new under the sun. Today there are 10–20 million known chemical compounds, 90% of which are organic. A good part of these organic compounds were already programmed in the nineteenth century, at least mathematically, by the analytical forms called trees.[11]

Trees are basic constituents of chemical structures. Cayley used trees and the usual algebra to count acyclic molecules; however, trees differ from most algebras in that operations are primitive, i.e., they have fewer properties than most algebras. Ordinary numbers are immune to change of order or association, but when these operations are applied to elements of trees, a distinct tree results. The domain of trees is ideal to represent chemical elements with which the molecules grow. We harvest the technique developed for tree enumeration in number operations and use it on the growth of trees. That is, the equation for counting, eq. (1), is also used for tree generation. This grafting works exceedingly well. When x is a number, trees of the same size (same number of nodes) are lumped together, but when x is a node of a tree, each tree is uniquely represented. Variable x is a chemical element and thus has lost all versatile features of a number.

Chemical structures are more restricted than mathematical trees in two aspects. First, nodes in chemical formulas are structured, whereas those in trees are not. Carbon atoms are tetravalent and tetrahedral in shape for saturated compounds (no multiple bonds). Second, if a carbon atom is bonded to less than four other carbons, it is padded with hydro-

gens. With the first aspect taken into account, eq. (1) can be reduced to[12]

$$a(x) = 1 + (x/6)\{[a(x)]^3 + 3a(x)a(x^2) + 2a(x^3)\}. \quad (2)$$

How does eq. (2) become a generator of chemical formulas? We view the growth of trees from two angles, one from the equation and the other from its solution $a(x)$. Eq. (2) reveals the growth process, whereas its solution gives individual tree structures. Key for solving eq. (2) is iteration. Meanwhile, a homologous series (such as the alkane series) of acyclic chemical compounds is generated graphically through iteration. Structures are produced exclusively and exhaustively by first principle. Iteration is carried out by approximating $a(x)$ successively as a_0, a_1, a_2, etc. As in trees, when x is a number, eq. (2) is an ordinary algebraic equation used for enumeration. When x is an atom, $a(x)$ represents a series of chemical structures. Hydrogen padding is carried out by setting a_0 equal to H. The first term in eq. (2), namely 1, is symbolized as a hydrogen atom H and used as the iteration initiator a_0; each x is a carbon atom C. Now $a(x)$ becomes a function of two variables

$$a(H,C) = H + (C/6)\{[a(H,C)]^3 + 3a(H,C)a(H^2,C^2) + 2a(H^3,C^3)\},$$

and is iterated as follows,

$$a_{n+1}(H,C) = H + (C/6)\{[a_n(H,C)]^3$$
$$+ 3a_n(H,C)a_n(H^2,C^2) + 2a_n(H^3,C^3)\},$$

leading to the solution

$$a_0 = \cdot H$$
$$a_1 = \cdot H + \cdot CH^3$$
$$a_2 = \cdot H + (\cdot C/6)[(H + CH^3)^3 + 3(H + CH^3)(H^2 + (CH^3)^2) + 2(H^3 + (CH^3)^3)]$$
$$= \cdot H + \cdot CH^3 + \cdot CH^2CH^3 + \text{higher terms}$$
$$a_3 = \cdot H + \cdot CH^3 + \cdot CH^2CH^3 + \{\cdot CH^2CH^2CH^3 + \cdot CH(CH^3)^2\} + \text{higher terms}$$

where dots $\cdot$ are added in front of the roots H or C to represent the radical nature of these atoms. Sequence a_n grows at each successive iteration by adding terms of nth order, which come from linking lower-order terms to the root. Merely by lowering superscripts into subscripts, sequence a_n becomes alkyl radicals (C_nH_{2n+1}) collectively. Iteration also modifies the meaning of the equal sign, which now stands for 'replaced by,' as used in programming language.

Four remarks on eq. (2) are in order. First, iteration is a growth process, but molecules viewed as mathematical trees do not grow exactly as biological trees. Existing mathematical trees are used as

branches and bonded to the root to form new trees. Molecules grow only from the root (not from other nodes) and do not grow bigger; they grow by forming new alkane molecules. Each carbon atom has four valences, with one pointing to the root and three pointing away; we can call them one stem and three branches. The root has three branches and no stem. Second, as variables in eq. (2) are reinterpreted as atoms C and H, operations become primitive. This results in terms that are all distinct from one another, exactly what a proper structure generator needs. For instance, there are two distinct C^3H^7 terms, representing two propyl radicals. Third, each carbon atom is tetrahedral and hence has three equivalent sites for bonding. Eq. (2) must obey the Pólya enumeration theorem[13] and engender molecular group symmetry C_{3v}. Note that the symmetry applies to the sites but not necessarily to the actual molecules. The three terms in the curly brackets of eq. (2) correspond to elements of C_{3v}, with coefficients 1, 3, and 2, the groupings in C_{3v}. Within the constraint of tree operations and node symmetry C_{3v}, eq. (2) generates unique structures. Nodes of nitrogen or oxygen atoms are even simpler and can be appended to eq.(2), as seen in Section V. Fourth, symmetry reduces the number of molecular structures. Pólya's theorem rationalizes and quantifies this fact.

IV. Free Alkane Series (C_nH_{2n+2})

In each structure generated by eq. (2), the root is affiliated with the radical quality of each alkyl radical. Our next task is to remove the root. For trees with no constraint from chemical valence, the roots are removed by using Otter's formula.[8] But chemical structures are either a subset of trees, such as the alkane series, or its extended version, such as the organic compounds shown in the next section, with more than one kind of root for growth. For these cases, or any other case except that of genuine mathematical trees (made of structureless lines and nodes), Otter's formula is no longer right and has to be replaced by a more general form, that of the dissimilarity characteristic theorem[9] (DCT). DCT is not limited to graphs with the constraint of chemical valence. A big plus of DCT is that it survives converting the domain of variables from numbers to chemical elements. In other words, the expression of DCT is also a structure generator. Besides, DCT is a generalization of Euler's characterization theorem (see below in this section). The essential idea of DCT is this. Contrary to what Fig. 3 implies, root-free trees do not come from literally unlabeling rooted species, but from combining rooted trees of smaller size. Two rooted trees are combined to lose their roots, resembling two radicals/spins combined to form a non-radical with no spin. The result is a root-free (or free) mole-

cule. Radicals outnumber free molecules, as seen in Fig. 3, because a molecule can be built from two radicals in many ways. When two radicals are combined, radicality (the label * in the graph) could remain on either side of the link or, alternatively, on the link itself, resulting in two node-labeled molecules and a link-labeled one. Every node-labeled molecule cancels a link-labeled one numerically. After cancellation, the amount left is the same as the number of free molecules. If the number of node-labeled molecules is p and link-labeled ones q, the count of free molecules φ is $\varphi = p - q$. This result is correct only if the two parts are dissimilar from each other. If they are the same, there is only one node-labeled species. Therefore, the net count should be corrected by adding a link-centered species, namely, a molecule made of two equal halves. The above argument works for multi-link molecules as well as single-link ones (diatomics). The count of free molecules is the difference between node-labeled species and link-labeled species with a correction whenever link-centered species r exist. Namely, the net count should be $\varphi = p - q + r$. Consider butanes for example (Fig. 4).
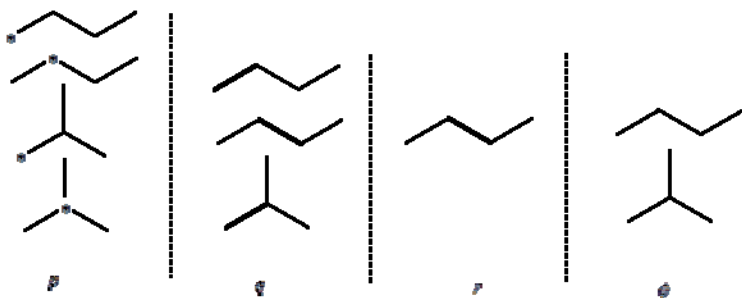
Fig. 4. Unlabeling butanes: p (node-labeled) $-$ q (link-labeled) $+$ r (center-labeled) $= \varphi$ (label-free).

Let us imaginatively label one node with the isotope ^{14}C in each butane. There are four node-labeled butanes. A link can be labeled with isotope ^{14}C on both sides of the link as shown in Fig. 4. There are three link-labeled species and a link-centered one. So, there are $4 - 3 + 1 = 2$ butanes. The structures represented by p, q, and r are conveniently calculated from rooted species a, which now is a function of H and C, as follows:

$$p(H,C) = (C/24)\{[a(H,C)]^4 + 6[a(H,C)]^2 a(H^2,C^2) + 8a(H,C)a(H^3,C^3)$$
$$+ 3[a(H^2,C^2)]^2 + 6a(H^4,C^4)\}$$

$$q(H,C) = (1/2)\{[a(H,C)-H]^2 + [a(H^2,C^2)-H^2]\}$$

$$r(H,C) = a(H^2,C^2) - H^2$$

and

$$\varphi(H,C) = p(H,C) - q(H,C) + r(H,C).$$

Thus, with the help of DCT, we have turned a mathematical equation like eq. (2) into a machine that produces chemical structures. Quite remarkably, eq. (2) produces structures uniquely and exhaustively.

Three remarks are in order. First, knowledge may not follow chronological order. Pólya's theorem and DCT were not available in Cayley's time. Nonetheless, Cayley progressed in the right direction and obtained the correct result (understandably with minor computational errors). DCT proves to be an essential part of the scheme if we want to generate chemical structures. Work[6] that shuns DCT and claims a correction over Cayley's result is done *ad hoc* for counting and not able to generate structures. Second, DCT is none other than an extension of Euler's theorem, which states that the number of node-labeled species p is equal to that of link-labeled species q plus one, for an acyclic molecule with irregular shape. But, in reality, a molecule may possess symmetry, which corrects the formula to $p - q + r = 1$. In the case of a class of molecules, $p - q + r$ gives a count of the molecules. For such calculation, a concise source code has been written.[10] Third, eq. (2) does not include chiral isomers. Chiral structures of alkane molecules (C_nH_{2n+2}) have been enumerated by a modified[12] eq.(2), which can become a structure generator, too.

We have used this scheme on five categories of organic compounds. They are

1. Saturated acyclic compounds made of hydrogen and four common second-row elements C, N, O, and F.
2. Saturated acyclic compounds made of hydrogen and second-row elements C, N, and O, with no (N/O)–(N/O) connection.
3. Saturated acyclic compounds made of hydrogen and second-row elements C, N, and O, with no geminal (N/O) branches.
4. Acyclic compounds with multiple bonds between carbon atoms.
5. Aldehydes and ketones. They can be considered as a variation of Category II in the form of dehydrated geminal di-alcohols.

Formulas of enumerating these categories have thus been found for the first time and then converted to structure generators. In each category, a rooted species is generated first, and then DCT is used to

calculate free molecules. A rooted species is a radical but corresponds to a mono-substituted molecule with a substituent, such as a nitrile group or a halogen. Therefore, as a byproduct, any mono-substituted series can be enumerated or generated by carrying out the first portion of the procedure. The romance of chemistry with math has a fruitful production. We now show the result of Category 1 explicitly as an example of the method.

## V. Saturated Acyclic Compounds Made of Hydrogen and Second-Row Elements C, N, O, and F

Organic compounds contain four essential elements: H, C, N, and O. Using Cayley's scheme, we could include any one of the four second-row elements C, N, O, or F as root for growing acyclic organic molecules. In other words, we need to add three more terms in eq. (2) besides the one covering carbon. Thus, at the root, carbon can grow three branches, nitrogen two, oxygen one, and fluorine none. In turn, each branch can start with C, N, or O. These two alternating actions form an endless loop to produce all combinations of acyclic structures. The governing equation becomes

$$
\begin{aligned}
a(H,C,N,O,F) = &\cdot H + (\cdot C/6)\{[a(H,C,N,O,F)]^3 + 3a(H,C,N,O,F) \\
&\times a(H^2,C^2,N^2,O^2,F^2) + 2a(H^3,C^3,N^3,O^3,F^3)\} \\
&+ (\cdot N/2)\{[a(H,C,N,O,F)]^2 + a(H^2,C^2,N^2,O^2,F^2)\} \\
&+ \cdot Oa(H,C,N,O,F) + \cdot F.
\end{aligned}
$$

Again, as variables turn into chemical symbols, the equation becomes a structure generator. The number of structures is enormously larger than that of the alkane series. Algebraically, fluorine behaves as hydrogen. Therefore, iteration of eq. (3) starts with two elements, $\cdot H + \cdot F$, instead of hydrogen alone. With the padding of hydrogens and fluorines, the result gives all isomers of fluorine compounds. As a special case where only the $\cdot F$ term is added to the right side of eq. (2), we arrive at all fluorinated hydrocarbons. Terms covering a single root, be it C, N, O, or F, are simply additive. Versatility of Cayley's scheme is eminent. With fluorine being less prevalent in chemistry and to avoid cluttering the formulas, we shall drop all fluorine derivatives by setting F to 0 in what follows. The terms that come out the first iteration in solving eq. (3) are none other than the common radicals shown below

$$
\begin{aligned}
a(H,C,N,O) = &\cdot H + \cdot CH_3 + \cdot NH_2 + \cdot OH + \cdot CH_2CH_3 + \cdot CH_2NH_2 + \cdot CH_2OH \\
&+ \cdot NHCH_3 + \cdot NHNH_2 + \cdot NHOH + \cdot OCH_3 + \cdot ONH_2 + \cdot OOH + \ldots
\end{aligned}
$$

By going through the root-removing process using DCT, we arrive at the assembly of free molecules of Category 1 as

$$\varphi(H,C,N,O) = CH_4 + NH_3 + OH_2 + CH_3CH_3 + CH_3NH_2 + CH_3OH$$
$$+ NH_2NH_2 + NH_2OH + HOOH + ...$$
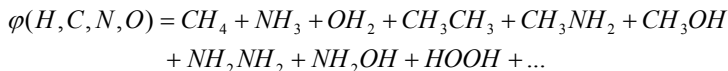
As easily seen, $\varphi(H,C,N,O)$ covers most plain organic molecules. Chemical structures are neatly laid out through *ab initio* calculation. When variables are set as real numbers, $H = 1$, $C = N = O = x$, and $F = 0$, the structure generators are converted to enumerators $a(1,x,x,x)$ [from eq. (3)] and $\varphi(1,x,x,x)$. For saturated acyclic compounds made of C, H, N, and O atoms, counts of rooted and free chemical structures ordered by size (corresponding to the sum of C, N, and O atoms, as shown in the exponents) are

$$a(1,x,x,x) = 1 + 3x + 9x^2 + 39x^3 + 181x^4 + 921x^5 + 4920x^6 + 27408x^7 +$$
$$156948x^8 + 919361x^9 + 5480371x^{10} + ...$$

and

$$\varphi(1,x,x,x) = 3x + 6x^2 + 18x^3 + 65x^4 + 258x^5 + 1140x^6 + 5436x^7 +$$
$$27262x^8 + 142311x^9 + 766073x^{10} + ...,$$

respectively. Each count of x^n corresponds to a distinct chemical structure of size n. With eq. (3) as another example, a mathematical equation is turned into a chemical structure generator. Details will be presented elsewhere.

VI. Conclusion and Prospect

In five categories of organic compounds, we are able to generate chemical structures exclusively and exhaustively using an *ab initio* method. It is demonstrated that mathematical variables can serve as chemical symbols and mathematical equations are chemical structure generators. The method starts as a counting tool for tree structures but finds a much better use as a chemical structure generator. This *ab initio* structure generating tool has a prospective use: It is more direct, more intuitive, and less error-prone than the currently popular algorithmic methods[1] used for organizing chemical compounds in a chemical data bank. One drawback of Cayley's method is its failing on polycyclic structures. Static cyclic structures are covered by Pólya's theorem, but growth on cyclic structures similar to tree growth hits a wall. Seeking a breakthrough in this topic has haunted chemists ever since, in spite of some limited success in polyhex systems.[14]

Acknowledgments

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Modeling Motion of a Small Black Hole Through a Star or a Planet

Victoriya V. Forsythe and Alexander M. Panin
Utah Valley University

Abstract

In some scenarios of the Big Bang, the fluctuations of density in the early Universe resulted in the formation of various-sized primordial black holes. The black holes of mass range 10^{11} to 10^{24} kg are suitable candidates for dark matter (or at least for a part of it). Such black holes could, from time to time, pass through the Solar System, the Sun, or even the Earth. What would a trajectory of a small black hole passing through the Sun or through the Earth look like? What other effects would take place? We modeled computationally the motion of a small black hole moving with various inertial velocities (10–1000 km/sec) through a planet-like and a star-like body of various density distributions. The results of this modeling show that a passing black hole would not destroy the planet or the star, nor significantly slow down by matter resistance of the host planet or star. The passage of a black hole with a mass of more than 10^{16} kg through Earth may be detectible by generated shock/acoustic waves, while the passage of a larger black hole with a mass of more than 10^{20} kg will generate a noticeable earthquake. The passage of a black hole of a mass of less than 10^{20} kg

through the Sun is practicably unnoticeable. Because of the low density of dark matter, the number and density of black holes with a mass of more than 10^{20} kg is so low that the passage of such black holes through the Sun, because of the lifetime of the Sun, is extremely unlikely.

Introduction

About 22% of the Universe consists of a mysterious dark matter (DM) [3], the nature of which is still unknown. There are suggestions that it may consist (at least in part) of small black holes (BHs) left over from the early dense era of the Big Bang expansion as topological "defects" of space–time [2]. Recent observations have shown that big BHs are common in the Universe. Almost all galaxies have super-massive BHs at their centers, and there are also 14 stellar-mass black hole candidates that were discovered in the Milky Way [3]. Smaller black holes are practically impossible to detect with present technology.

Estimated in 2010, the Hubble parameter gives a critical density of the observable Universe to be 9.30×10^{-27} kg/m^3, so DM density is $\sim 2 \times 10^{-27}$ kg/m^3 [3]. The mass of primordial BHs cannot be smaller than 10^{11} kg, because the evaporation time of less massive BHs is much less than the age of the Universe (see Fig. 1b). On the other side, BHs more massive than $m \sim 10^{24}$ kg can (in theory) be observable by their gravitational force [4]. Therefore, we focused our analysis on the BHs in mass range 10^{11} to 10^{20} kg as prime candidates for the part of DM content.

The Probability for a Small Black Hole to Hit the Sun or the Earth

Small BHs, despite their large mass, have a very small event horizon radius (aka Schwarzschild radius R_s), which is given by the equation (1):

$$R_s = \frac{2Gm}{c^2} \qquad (1)$$

which varies from 10^{-16} meters for $m \cong 10^{11}$ kg to 10^{-7} m for $m \cong 10^{20}$ kg (Fig. 1a). Note here that a typical nucleus has a diameter $\sim 10^{-14}$ m, and a typical interatomic distance is $\sim 3 \times 10^{-10}$ m.
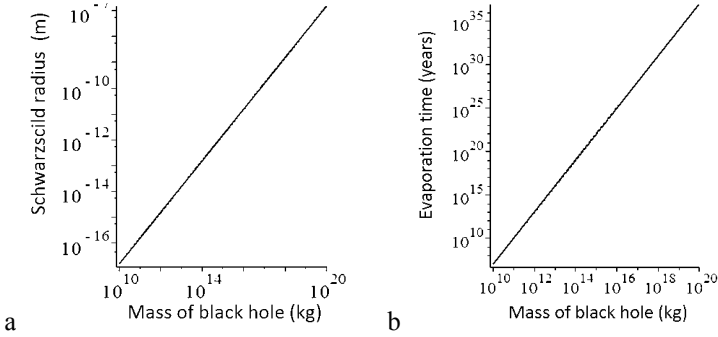
Fig. 1. (a) Graphs showing the event horizon radius R_s and (b) the evaporation time of BH (due to Hawkins radiation) as the functions of BH mass.

Because of the very small density of DM on one hand and a large mass concentrated even in a small BH on the other hand, the needed number density of BHs to constitute DM is very small. Indeed, a gas cloud of BHs of mass m ~ 10^{11} kg has the number density about 2×10^{-38} m^3. Such density corresponds to the average distance between BHs ~ 3.4 light hours, whereas BHs with the mass m ~ 10^{20} kg are separated by about 0.4 light years. Assuming Maxwellian distribution of velocities of galactic BHs, with the average velocity corresponding to the observable orbital velocities of the majority of stars in our Galaxy, $v \approx 200$ km/s, the probability of hitting the Sun can be estimated as $\omega \approx <nv\sigma>$, where n is the number density of BHs per m^3, v is the average velocity of BH in m/sec, and σ is the cross-sectional area of a target (the Sun) in m^2. For BHs of a mass of 10^{11} kg this probability is equal to 3×10^{-14} sec^{-1}. This probability corresponds to approximately one collision per about a million years. For BHs of a mass of 10^{20} kg this time is significantly larger, about 10^{15} years. So, a collision of larger mass BHs with a particular star is extremely rare. There are approximately 100 billion stars in the Milky Way galaxy, so the probability of hitting any star is once in every 5 minutes for 10^{11}-kg BHs and once in 10^4 years for 10^{20}-kg BHs.

The probability of hitting the Earth is much less (because of a much smaller cross-sectional area of Earth); it might happen once in ~10 billion years for 10^{11}-kg BHs and once in 10^{19} years for 10^{20}-kg BHs. Again, considering that there seems to be about 10^{11} Earth-like planets in the Milky Way, the probability of hitting any Earth-sized planet is once a year for 10^{11}-kg BHs and once in 10^9 years for 10^{20}-kg BHs.

Velocities of Extraterrestrial Black Holes

As all bodies in the Universe move with some velocity, BHs are not an exception. The velocity of solar system–bound BHs should be in the range of 30 to 70 km/sec, whereas galactic BHs should have ~200 km/sec velocity. With this high velocity, a BH can pass through the Earth in just about one minute. The gravitational pull of a planet or a star adds additional velocity to the BH. Because of the gravity of the Earth, a BH would gain ~11 km/sec by the time it crossed Earth's surface, even if it was not moving relative to Earth at $r = \infty$. Thus, the entering velocity is always higher than the escape velocity (the velocity needed to escape from a gravitational field without further propulsion). A BH with its initial velocity of 200 km/sec that is going to hit the Sun gains ~620 km/sec at the Sun's surface (and it keeps increasing its speed inside of the Sun). It will gain its maximum velocity of 1000 km/sec when passing near the Sun's center (Fig. 2a). Our simulation shows that such a fast-moving BH would propagate through the Sun almost in a straight-line trajectory (Fig. 2b) in about a half hour.

a   b
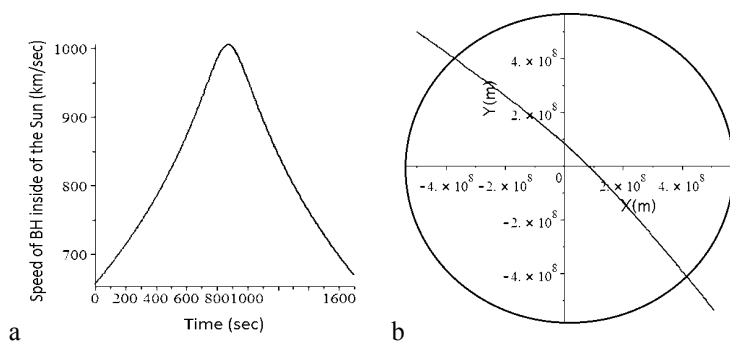
Fig. 2. (a) Graph showing the speed of a BH (with the initial velocity 200 km/sec at infinity) passing through the Sun. Note that it already gains velocity v ~ 600 km/s by the time of crossing Sun's surface at $t = 0$. (b) Illustration of the trajectory of motion of a BH with the initial velocity 200 km/sec (at infinity) inside the Sun.

Resistance by Matter to BH Passage

Direct trapping of matter by a BH passing through a star or a planet is practically negligible. If one considers that a BH traps only the matter that passes through its horizon radius (Fig 3), then the calculation gives the result that a BH with a mass of 10^{20} kg traps only ~10 g

of solar matter passing through the Sun, and only ~0.3 g of matter passing through the Earth. The numbers are much smaller for lighter BHs: A BH with a mass of 10^{11} kg traps just ~10^{-17} g passing through the Sun, and ~3×10^{-19} g when passing through the Earth. These numbers are so much smaller than the masses of corresponding black holes that neither BH is noticeably slowing down nor is any star or planet losing practically any mass.
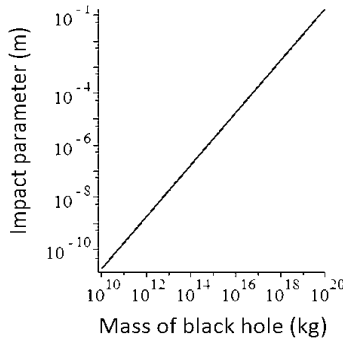
Fig. 3. Graph showing the effective impact parameter (the distance from BH at which the momentum of passing by matter changes by mv (so $\theta = 90°$)) for BHs of various masses.

A strong gravitational force of even a small BH actually extends over a much larger distance than the event horizon radius. The problem with estimating the transient disturbance of a BH passing through matter at a high speed is difficult to solve in the reference frame of resisting matter. It is easier to consider it in the reference frame of a BH. This problem then becomes very similar to the Rutherford scattering problem, but with the attractive instead of repulsive potential. At distances more than a few event horizon radii R_s, gravity of a BH is practically Newtonian, and at smaller distances the amount of disturbed matter is negligible as shown above. This problem can be solved without involving general relativity (GR). Then, the dependence of the scattering angle θ on the impact parameter b (which is defined as the perpendicular distance between the undisturbed path of a projectile and the center of scattering mass (Fig. 4)) is given by Equation (2).

$$\tan\left(\frac{\theta}{2}\right) = \frac{Gm}{bv^2} \qquad (2)$$
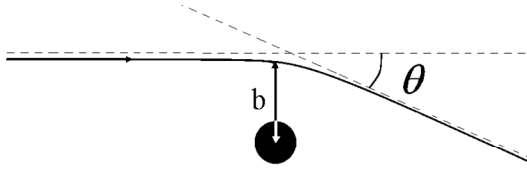
Fig. 4. Illustration of the scattering angle θ and the impact parameter b of gravitational scattering of the incoming matter.

The force of resistance between the matter and a BH can be calculated as a derivative of the momentum of a BH with respect to time:

$$F_{resist} = \frac{dp}{dt} = \frac{vdm}{dt} = \frac{v\rho\sigma dx}{dt} = v^2\rho\sigma \qquad (3)$$

where ρ is a density of matter and σ is an effective cross-sectional area of matter that a BH disturbs:

$$\sigma = \pi b^2 = \frac{\pi G^2 m^2}{v^4} \qquad (4)$$

At high speed this equation is similar to an aerodynamic drag equation.

The dependence of the drag force of a BH propagating in matter at the speed 200 km/sec through the Sun's core with a density of 160 g/cm³, Earth's core with a density of 11 g/cm³, water with a density of 1 g/cm³, and air with a density of 0.0013 g/cm³ is shown in Figure 5A. The deceleration due to that matter resistance drag force is shown in Figure 5B. This deceleration is negligible compared with the acceleration of gravity of the host body. Even for a more massive BH with a mass of 10^{20} kg, deceleration is only $\sim 10^{-11}$ m/s².

Shock Wave Generated by Black Hole Passage

When a BH is propagating through matter at high speed, a shock wave is generated. The energy of generated shock wave can be estimated as follows. Because of the resistance force (Eq. 3), part of the kinetic energy of passing BH is converted into acoustic/shock wave with the rate:

$$P = F_{resist}v \approx v^3\rho\sigma \qquad (5)$$
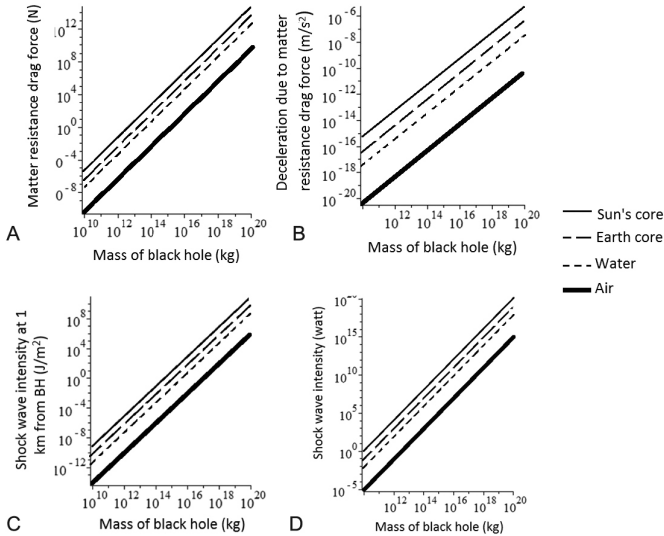
Fig. 5. (A) Graph showing drag force for BH propagating in matter at the speed 200 km/sec. (B) Graph showing deceleration of BH propagating at speed 200 km/sec due to matter resistance. (C) Graph showing generated shock wave intensity. (D) Graph showing shock wave intensity at 1 km from a BH.

If the speed of a BH is higher than the local speed of sound in matter through which a BH is propagating, then most of this energy goes into a shock wave (and eventually into heat). This is the case when a BH is propagating through a planet. For a star, a BH propagating with a speed of 200–1000 km/s generates an acoustic wave.

The intensity of a shock wave for a BH with a mass of 10^{20} kg propagating through a planet can be compared with a very strong earthquake (Fig. 5C, D). Note here that while the earthquake-generated energy is initially concentrated in a very small space (about few km in size), the energy of a BH shock wave is spread over a very large path length (~10^7 to 10^8 m). Thus, the effect of this shock wave is far less noticeable. For example, the intensity of the shock wave expressed in Joule/m^2 at the distance 1 km from a passing BH is negligible for a BH with a mass of 10^{16} kg.

Gravitational Tidal Force of Passing BH

A tidal force is the difference in a gravitational force at different distances from a BH. A strong enough tidal force can tear compound

structures like molecules, atoms, and even nuclei apart [5]. Let's esti-
mate at what distance from a passing BH (with a mass range of 10^{11}–
10^{20} kg) the tidal force is strong enough to dissociate a molecular mat-
ter, ionize atoms, and split nuclei. The bonding energy of an atom in a
molecule, an electron in an atom and a nucleon in a nucleus is of the
order of Coulomb energy

$$U_C = \frac{1}{4\pi\varepsilon_0}\frac{Ze^2}{r} = 9.0\cdot10^9\frac{Z_{eff}e^2}{r} \qquad (6)$$

where $e = 1.6 \times 10^{-19}$ C is charge of electron, r is the average distance
between bonded parties (neighboring atoms in a molecule or a solid, an
electron–nucleus distance in an atom, a distance between neighboring
nucleons in a nucleus). Z_{eff} here is the effective charge number. For
example, for outermost electron in an atom $Z_{eff} \sim 1$, for innermost elec-
tron $Z_{eff} \sim Z_{nucleus}$, for nucleons $Z_{eff} \sim Z_{nucleus}$. Indeed, for a typical in-
teratomic distance r $\sim$ 0.3 nm (and $Z_{eff} \sim 1$), this formula gives
U $\sim 8 \times 10^{-19}$J = 5 eV, which is close to a typical bonding energy of
atoms. For an innermost electron, for example Na atom, U $\sim$1.3 keV is
close to actual 1.1 keV ionization energy. For a nucleon in a typical
nucleus (where at r$\sim$10^{-15} m, there are about $Z_{eff} \sim$8 effective immediate
neighbors), the above formula results in U $\sim$ 9 Mev, which is a quite
reasonable estimation of actual bonding energy of average nucleon.

The order of magnitude of the tidal force ΔF tearing apart a struc-
ture of the characteristic size Δr (at the distances r from a BH exceed-
ing a few event horizon radii) can be estimated by differentiating
Newtonian gravitational force over a distance:

$$\frac{\Delta F}{\Delta r} \sim \frac{\partial F}{\partial r} = 2G\frac{Mm}{r^3} \qquad (7)$$

Then the distance r_{tidal} from a passing BH at which such structure can
potentially be disintegrated by the BH's tidal forces is given by the
above equation solved for r:

$$r_{tidal} = (2G\frac{Mm\Delta r}{\Delta F})^{\frac{1}{3}} \qquad (8)$$

Substituting here for ΔF the Coulomb force

$$F_c = \frac{U_c}{\Delta r} = \frac{1}{4\pi\varepsilon_0}\frac{Z_{eff}e^2}{(\Delta r)^2} \qquad (9)$$

holding the structure of the size Δr together, we get the following equation for the destructive range of BH tidal force for atomic and nuclear matter:

$$r_{tidal} = \Delta r \cdot (GMm \frac{8\pi\varepsilon_0}{Z_{eff}e^2})^{\frac{1}{3}} \qquad (10)$$

The most abundant molecules in Earth are SiO_2 and Al_2O_3 molecules composed of atoms of average atomic mass $m \sim 20u = 3.2 \times 10^{-26}$ kg separated by the distance $\Delta r \sim 0.3$ nm and bonded by a few eV energy U_c (with $Z_{eff} \sim 1$). The tidal destruction range of BH of the mass M is

$$r_{tidal} = \Delta r \cdot (Gm \frac{8\pi\varepsilon_0}{Z_{eff}e^2})^{\frac{1}{3}} M^{\frac{1}{3}} = 2.7 \cdot 10^{-3} \Delta r \cdot M^{\frac{1}{3}}$$

$$(11)$$

For a BH with a mass of 10^{11} kg, this gives $r_{tidal} \sim 3.7 \times 10^{-9}$ m, and for a BH with a mass of 10^{20} kg $r_{tidal} \sim 3.7 \times 10^{-6}$ m. The total mass of molecules disintegrated by BH passage along BH path in the Earth ($R_{Earth} = 6.4 \times 10^6$ m, $\rho \approx 5500$ kg/m^3) is about 1.4×10^{-6} kg for a 10^{11}-kg BH and ~ 1.4 kg for a 10^{20}-kg BH. The energy that a BH loses from disintegrating this amount of matter is then

$$E_{tidal} = U_C \frac{m_{dis}}{m} = U_C \frac{\pi r_{tidal}^2 \rho R_{Earth}}{m} = 2\pi\rho\Delta r R_{Earth} G^{\frac{2}{3}} (\frac{1}{\pi\varepsilon_0} \frac{Z_{eff}e^2}{m})^{\frac{1}{3}} M^{\frac{2}{3}} \quad (12)$$

and is only 70 J for a 10^{11}-kg BH and 70 MJ for a 10^{20}-kg BH, resulting in additional dissipating force

$$F_{diss} = \frac{E_{tidal}}{2R_{Earth}} = \pi\rho\Delta r G^{\frac{2}{3}} (\frac{1}{\pi\varepsilon_0} \frac{Z_{eff}e^2}{m})^{\frac{1}{3}} M^{\frac{2}{3}} \qquad (13)$$

which is equal to only 5.6×10^{-6} N for a 10^{11}-kg BH and 5.6 N for a 10^{20} kg BH, resulting in the additional deceleration of 5.6×10^{-17} m/s^2 and 5.6×10^{-20} m/s^2 correspondingly, which is negligible compared with the gravitational acceleration of Earth.

Similar analysis for BHs propagating trough the Sun also gives negligible deceleration compared with the gravitational acceleration of the Sun.

A process involving a tidal ionization and a tidal nuclear fission contribute into the dissipative force (eq. 13) even less mainly because of the smaller sizes Δr of the bound structures involved: smaller sizes of wave-functions of inner electrons (which range from $\Delta r \sim 10^{-10}$ m to 10^{-12} m) and much smaller size of nuclei (10^{-15}-10^{-14} m).

Conclusion

Part of DM can be a gas of primordial BHs with a mass of 10^{11}–10^{20} kg. Such BHs may have initial speed (depending on the trajectory of their motion) ranging from 30 to 200 km/sec. From time to time they can pass through stars and planets. Collision of a BH with the Sun is rare but possible. The observations of shock wave signatures may reveal the transit of a large BH through a star. The collision of a BH with a mass of 10^{11}–10^{20} kg with the Earth is extremely unlikely. Passing through a star or a planet, a BH cannot destroy it; however it can cause an effect similar to an earthquake. Matter resistance for a BH moving with a typical galactic speed is negligible, as well as is the deceleration due to the dissociation and ionization of molecular and atomic matter by tidal force; a BH passes through a star or planet without any slow-down. Shock waves or acoustic waves generated may, however, be observable for a BH of a large mass (10^{16} to 10^{20} kg).

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The Effect of Surface Roughness on Reflected Intensity

Gregory R. Hart and R. Steven Turley
Brigham Young University

Abstract

We quantitatively characterized the effect surface roughness has on extreme ultraviolet radiation by taking the ratio of the reflectance of a surface with random roughness and the reflectance from a perfectly smooth surface of the same composition and size. The reflectance was calculated by numerically solving the exact integral equations for the electric and magnetic fields for s polarization. The surfaces had Gaussian noise in one direction and were invariant in the other. The reflectance for the rough surface was averaged from many different random surfaces. To determine the parameters that affect this ratio, we varied angle of incidence, rms height of the roughness, thickness of the substance, real and imaginary parts of the index of reflection, and frequency cut-off for the random noise on the surface. We determined that in the extreme ultraviolet only the angle and rms height mattered. We did a fit to create a correction factor and compared it with Debye-Waller and Nevot-Croce correction factors.

1 Introduction

The extreme ultraviolet (XUV) is a portion of the electromagnetic spectrum bridging ultraviolet and X-rays (1–100 nm). In recent years, interest in XUV has greatly increased because there are possible applications in photolithography,[1,2] astronomy,[2,3,4] and microscopy.[5] Microchips are fabricated using photolithography, a process of projecting an image onto photosensitive material to etch the pattern of the integrated circuit. This technique is limited by the resolution of the light used. By using a shorter wavelength, i.e., XUV light, smaller and hence faster chips can be produced. For XUV photolithography to be practical, however, the mirrors need to be highly efficient to reflect enough light onto the surface. In astronomical observations, every wavelength has something to contribute. There are many distant energetic objects that could be better observed with improved XUV optics. Also, XUV can help in observations of closer objects. The earth's magnetic field traps singly ionized helium atoms, which radiate predominately at 30.4 nm. Thus, NASA's IMAGE satellite was equipped with XUV optics allowing it to observe the magnetosphere in new ways, increasing our understanding.[3,6] In microscopy, XUV has much to offer in the imaging of tissues and organisms. Viruses, bacteria, and many parts of animal cells are barely, if at all, resolved by visible light. XUV provides better resolution and easier sample preparation than for a tunneling electron microscope (TEM). It also provides better contrast then a TEM because water is transparent in some of the XUV, but carbon is opaque.[7]

All of these applications rely on improvements in XUV optics. Few materials reflect XUV, and those that do, do not reflect it strongly. This problem is further compounded by the short wavelength of XUV. When making a mirror, there will be imperfections in the surface, and their size is comparable to the wavelength of XUV light. These imperfections or roughness cause the light to be reflected at different angles, decreasing the reflected intensity. Understanding exactly how the roughness affects the reflection will allow for better designed mirrors, maximizing reflectance. In addition, understanding the effect of surface roughness is important in using reflection and transmission measurements to determine the complex index of refraction of materials in the XUV range.[8] It is important to know the index of refraction in order to design optics using various materials.[9,10] The Fresnel coefficients are used to find the reflected or transmitted field for a flat surface. The Fresnel coefficients depend on the incident angle and the index of refraction for the materials on both sides of the interface.

We will represent the effect of the roughness with a correction factor that is multiplied with the expected reflection from a smooth

surface, which can be found with the Fresnel coefficients. The correction factor is a function of the properties of the material and mirror, such as rms (root mean square) roughness height, index of refraction, and thickness. The rms roughness height is a measure of how much the rough surface deviates from the flat surface. Simply taking the average of difference between the flat surface and rough surface would return zero since the rough surface extends both above and below a flat surface. Instead, by squaring the difference of the two, everything is positive and then the average is taken. Then, since the values were squared, we take the square root of the average.

$$\sqrt{\frac{1}{n}\sum_{i=1}^{n}(y-y_i)^2}$$
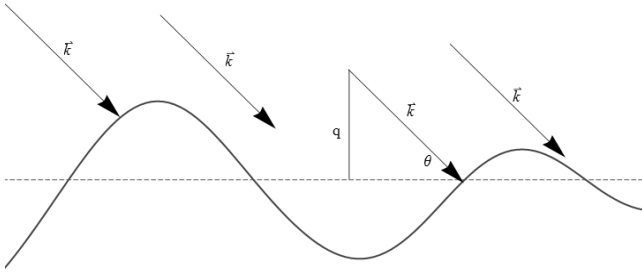
Fig. 1. Illustration showing the geometry of the surface. The dashed line represents the corresponding flat surface. The solid line is the actual surface. The arrows represent the incoming light. θ is the angle the incoming light makes with the flat surface, and q is the component of the light's momentum perpendicular to the flat surface.

There are two commonly used correction factors, Debye-Waller and Nevot-Croce, which have the form

$$R = R_o e^{-4q^2 h^2} \qquad\qquad (1)$$

$$R = R_o e^{-4q_1 q_2 h^2} \qquad\qquad (2)$$

where h is the rms height of the roughness and q is the component of the light's momentum perpendicular to the flat surface given by .

$$q = \frac{2\pi n}{\lambda_{\mathrm{O}}}\,\mathrm{Sin}\,\theta\,.$$ Here n is the index of refraction, λ_0 is the wave-

length in vacuum, and θ is the angle from grazing from the flat surface (see Fig. 1). The difference between these two is that Debye-Waller is evaluated on one side of the interface (q^2) and Nevot-Croce is evaluated on both; q_1 is on one side and q_2 is on the other. These two correction factors appear to work fairly well for different angle ranges. The correction factor is a function of just three parameters: rms roughness (h); incident angle (θ); and the index of refraction (n). de Boer[11] derived a more general expression that simplifies to Debye-Waller and Nevot-Croce at the angles where they are most accurate; it relies on an addition parameter: the lateral correlation of the roughness profile. Stearns[12] derived a very general method for calculating the scatting off any non-ideal surface; however, it relies on the assumption that the reflection is weak, and our goal is to get the reflections as strong as we can. Therefore, we are looking for something with similar form to Debye-Waller, but expect a difference because of the underlying assumptions about the roughness and approximations in previous calculations.[13,14,15,16]

2 Procedure

Our model of the surface is broken into four different parts: top, bottom, left side, and right side. The two sides are semi-circles with diameters equal to the thickness of the mirror. To minimize the effect of the second interface, we made the bottom surface flat. The top surface, which is the one the light impinges on, has the roughness that affects the reflection (Fig. 2). The roughness is described by the rms height of the top surface. Our surfaces are invariant along the axes not show in the figure. So the roughness only affects the reflection in one direction.
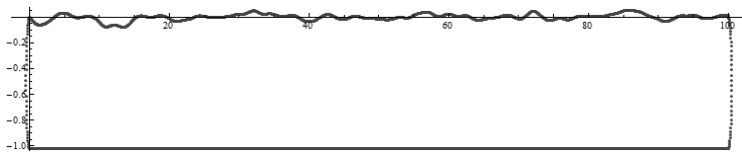

Fig. 2. Illustration of an example surface. Both axes are in units of wavelength but the aspect ratio is not 1:1. The surfaces are very long and skinny. The ends are semi-circles even though they look almost flat in this figure. The bottom is flat and the top has rms height of .1 wavelengths.

Both Debye-Waller and Nevot-Croce assume that the roughness is Gaussian noise centered around the flat surface. Several XUV mirrors were examined with atomic force microscopy (AFM). The surfaces, as measured with AFM, were put through a Fourier transform. This revealed that there is very little high frequency noise on the surface.[9, 17]

A random Gaussian distribution does not guarantee a low-frequency surface. To better model what was discovered with the AFM measurements we create surfaces by generating Gaussian noise on the surface. Then, we apply a Fourier transform to the surface. Once in frequency space we apply a low-pass half-Gaussian filter to remove any high frequencies in the Gaussian noise. Finally, we transform back to real space, carefully treating the phases to make sure that the result is a real valued function.[18]

To calculate the reflectance, we are using the electric and magnetic field integral equations. These are solved numerically using the Nystrom method.[19] We only used s polarization but p should follow soon. For every set of parameters, we calculated the reflectance off of a flat surface and 100 different randomly rough surfaces. We took the ratio of the peak intensities from each random surface with the flat surface and then averaged them. We use peak intensity because in our experimental setup the detector is narrow; however, these results may not be valid for a larger detector that may get extra intensity from side lobes or a boarder main lobe. We explored the effect of mirror thickness, frequency cut-off, and the real and imaginary parts of index of refraction. By varying incident angle, rms roughness, and one of these parameters at a time, we determined which significantly affects the reflected intensity.

3 Analysis

Since we expect that our correction factor will be similar to Debye-Waller and Nevot-Croce, rather than plotting and fitting the ratios of reflectance we use the negative natural log of the ratio. Thus, we are finding and looking at the exponent of the correction factor. Also, since Debye-Waller and Nevot-Croce are for surfaces that vary in two dimensions and our calculations are for a surface that varies in one, we multiply by $\sqrt{2}$. This factor of $\sqrt{2}$ comes from the assumption that the noise on a two-dimensional surface is the same in all directions so that the two-dimensional Gaussian varies from the one-dimensional Gaussian by a factor of $\sqrt{2}$ in the exponent. As we varied the different parameters, the following parameters were constant. The imaginary part of the index of refraction was 5. This caused high absorption so that there was little effect from the back side of the mirror, allowing us to

focus on what happens on the top surface. The real part of the index was 0.9. For most materials the real part of the index is close to 1 for the XUV. The thickness of the mirror was about 1 wavelength. The frequency cut-offs were 0.1 and 0.2 inverse wavelengths. The rms height varied from 2.5% to 10% of a wavelength and the angle from 5° to 85°.

The first parameter we tested was the width of the Gaussian filter used to cut off the frequency of the noise. We used frequency cut-offs from 0.05 inverse wavelengths to 2 inverse wavelengths. For the higher frequencies (2 to 0.2 inverse wavelengths), the ratio of the reflectance varied significantly as the cut-off frequency changed; however, as mentioned earlier, surfaces of actual XUV mirrors do not have high frequency noise and these frequencies (2 to 0.2 inverse wavelengths) are above what was observed to be realistic. When examining only results from surfaces with a frequency cut-off 0.2 inverse wavelengths or lower, there was much less spreading in the reflectance ratio (Fig. 3). As long as the frequency cut-off is below 0.2 inverse wavelengths, which it should be to model real surfaces, it causes little variation in the ratio of reflectance.
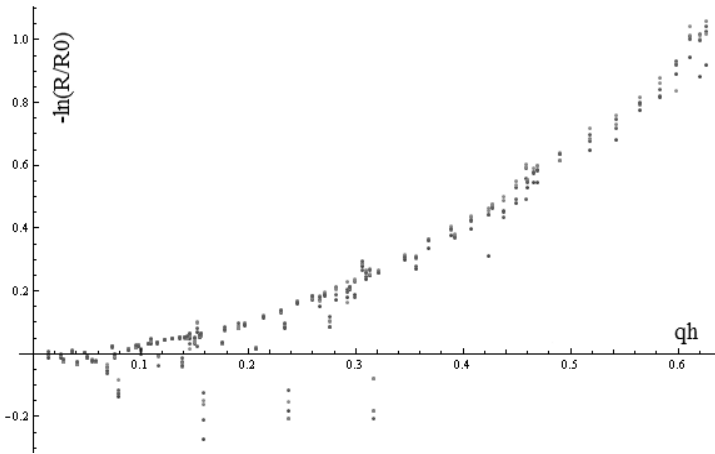

Fig. 3. A plot of the $-\ln\frac{R}{R_0}$ for varying frequency cut-offs on the Gaussian noise (ω). Five cut-off values were used from $\omega=0.2$ to $\omega=0.05$ inverse wavelengths. For each cut-off value, the reflectance ratio was calculated at 80 difference values of qh. The result appears to follow a parabola.

The next parameter we explored was the real part of the index of refraction (n). We used n values from 0.1 to 0.92. In the XUV, $n \approx 1$ for most materials, so this range of values extends beyond what we expect to encounter. The spread of the reflectance ratios is very narrow (Fig. 4). When finding the reflectance from a flat surface, the index of refraction plays a role because it appears in the Fresnel coefficients. By taking the ratio of the reflectance of the rough surface and the flat surface, the effect of n in the Fresnel coefficients cancels out, and we are seeing how the effect of roughness varies with n. This is significant because both Debye-Waller and Nevot-Croce depend on n. Furthermore, the spread in our ratios is smaller than the difference between Debye-Waller and Nevot-Croce for a single n. Therefore, n does not play a significant role in the attenuation of the reflection.
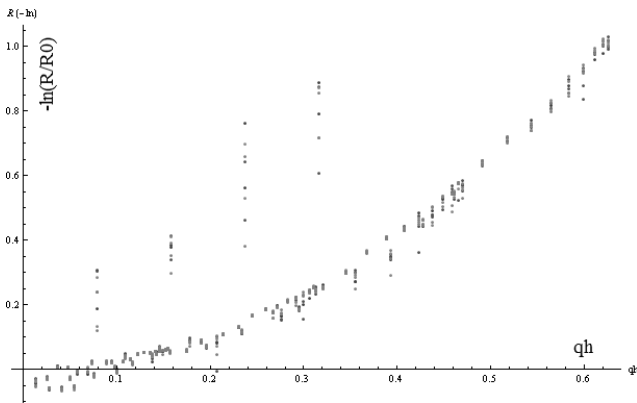
Fig. 4. A plot of the $-\ln\frac{R}{R_0}$ for varying real part of the index of refraction (n). Six values of n were used from $n=0.1$ to $n=0.92$. For each n value, the reflectance ratio was calculated at 80 difference values of qh. The result appears to follow a parabola.

Next, we explored the effect of the imaginary part of the index of refraction (β). We varied β from 0.01 to 15. In the XUV, materials tend to be very absorptive ($\beta>1$) so this range again goes beyond what we expect to encounter. For the values of $\beta\leq1$, there was significant interference from the bottom surface; however, as we increase β beyond one, this interference drops off and we find that β has little effect on the change in reflectance (Fig. 5).
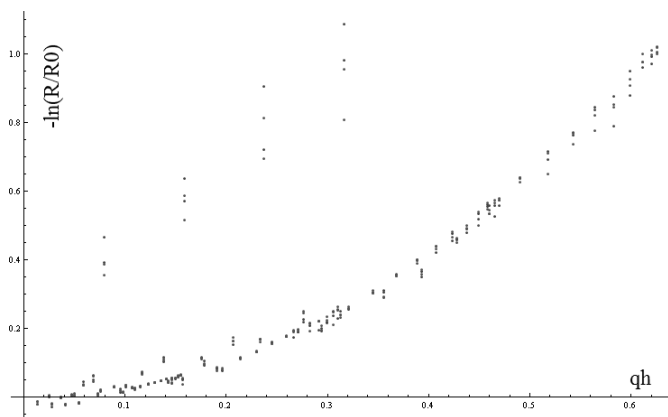
Fig. 5. A plot of the $-\ln\frac{R}{R_0}$ for varying imaginary part of the index of refraction β). Six values of β were used from $\beta=0.01$ to $\beta=15$. For each β value the reflectance ratio was calculated at 80 difference values of qh. The result appears to follow a parabola.

As can be seen in Figures 3, 4, and 5, there are always several values of qh for which the reflectance ratio greatly differs from the values of the neighbors. Examining these qh values, we found that they all have the same incident angle. Thinking that these spikes arose from interference with the back surface, we also explored the effect of thickness on the reflectance. We varied the thickness for 1 to 10 wavelengths, making sure to use thicknesses that were both an integer number and irrational number of wavelengths. Unsurprisingly, the locations of these change with thickness (Fig. 6), showing dependence.When the thickness is changed by an integer multiple, however, the spike—surprisingly—does not move back to where it started, which it is expected if it were caused by interference from the back surface. Accordingly, we are still trying to determine the origins of these spikes and, in the meantime, removed these outliers when fitting the data. We think that they might be numeric artifacts. We ran over a smaller angle range, centered on the spike, with higher resolution and found that the spike is not at a single point but is a small oscillation (Fig. 7). We think that this is arising from the Fourier transform and are investigating it further.
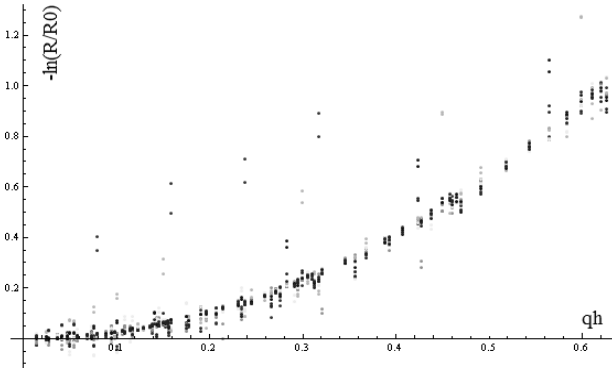
Fig. 6. A plot of the $-\ln\frac{R}{Ro}$ for varying thickness of the mirror (t). Six thicknesses were used from $t=1$ to $t=10$ wavelengths. For each thickness the reflectance ratio was calculated at 80 difference values of qh.
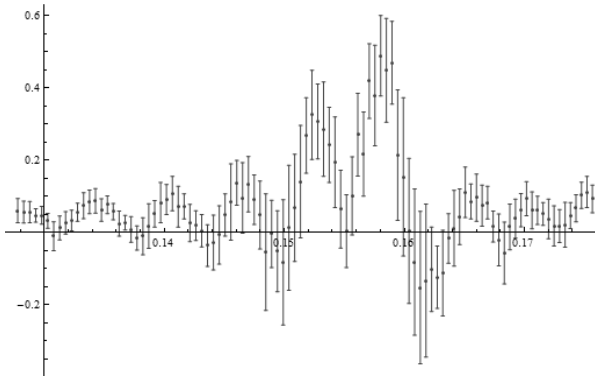
Fig. 7. A plot of the $-\ln\frac{R}{Ro}$ over an angular range of 24° to 34° with a fixed h and angular resolution of 0.1°.

To find the correction factor, we fit the data from varying the cutoff frequency to a third-order polynomial. We assumed that the constant term was zero because when qh is zero either the surface is flat ($h=0$) or we are just grazing the surface ($\theta=0$) and then roughness should have no effect. From the fit we have

$$-0.28qh+3.58(qh)^2-0.87(qh)^3$$

where the errors on the coefficients are 6.2%, 33.4%, and 39.3%, respectively.

4 Conclusion

The attenuation of reflected intensity for the XUV caused by surface roughness highly correlates with the exponential of a cubic function of rms height and incident angle

$$e^{-0.28qh+3.58(qh)^2-0.87(qh)^2}.$$

We also looked for correlations with index of refraction, spacial frequency, and thickness; however, no correlation was discovered, and if these parameters are kept within realistic ranges for the XUV, their effect on the reflectance is small compared with rms height and incident angle. Our correction factor is similar to the existing correction factor (Fig. 8); however, our q does not depend on index of refraction and, in addition to having a quadratic term (whose coefficient is slight different), we have linear and cubic terms. This new correction to the reflectance will allow for improvements in XUV mirror design and fabrication.
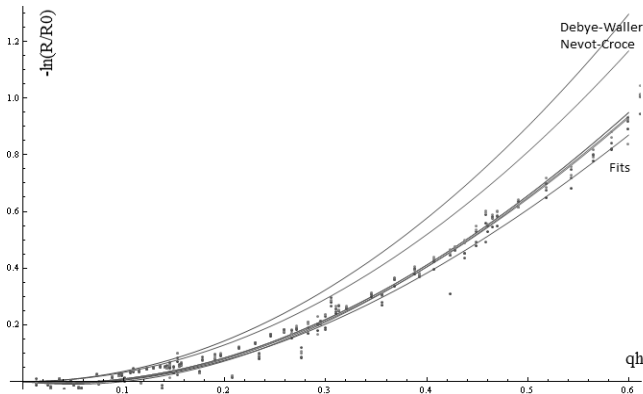
Fig. 8. This figure compares the fits with the existing correction factors. The top two curves are the Debye-Waller and Nevot-Croce factors. The lower curves are the fits of the data for varying the frequency cut-off. There is a curve for each value of the cut-off as well as one for the aggregation of all data. The actual data are overlaid for comparison.

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Non-Specular Reflectance in the Extreme Ultraviolet

Quintin Nethercott, Cody Petrie, and R. Steven Turley
Brigham Young University

Abstract

Surface roughness is critical in extreme ultraviolet (EUV) optics because the short wavelengths make optics much more sensitive to variations in surface height. We measured the non-specular reflection from two chrome samples and fit that data to a model to characterize their surface features. As a result, we have improved our ability to characterize surface roughness in the extreme ultraviolet by utilizing non-specular reflectance to complement and improve other methods for characterizing surface roughness, such as atomic force microscopy (AFM) and electron microscopy. From the analysis of these measurements, we determined the surface roughness height of our sample to be 1.1 ± 0.2 μm. With more work, we will be able to determine surface characteristics better than AFM and electron microscopy.

1. Introduction and Background

The current method of characterizing roughness using atomic force microscopy (AFM) is limited by the size of our tips to a resolution of about 3 nm. Because of how our thin films are fabricated, we don't expect electron microscopy to be any more accurate than this. We hope to provide a new and more efficient way of measuring deviations in surface height based on non-specular measurements. The purpose of this paper is to provide a proof of principle showing that we can determine surface features based on non-specular reflection. To establish the proof of principle, we used geometric optics because the size of the sample roughness was much greater than the wavelength of light. Geometrical optics is explained in more detail in section 3.1. For our normal samples, the surface features have sizes comparable to the wavelength of the incident light. Analyzing non-specular reflection from such surfaces would require more careful calculations, which are described in this volume by Hart and Turley [1].

1.1. *Non-specular reflection*

Specular reflection occurs when light reflects from a surface at the same angle as the incident beam, obeying Snell's Law. Geometrical optics treats light as rays, allowing one to trace the propagation of light as illustrated in Figure 1. However, when the surface is non-planar, the reflected light will scatter at different angles. This is called non-specular reflection and is illustrated in Figure 2.
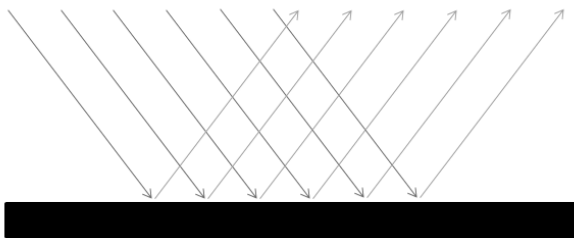
Fig. 1. In specular reflection, the reflected beams reflect at the same angle that they were incident to the surface.
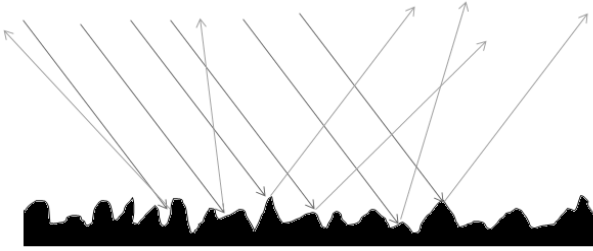
Fig. 2. In non-specular reflection, the reflected beams reflect at angles other than the angle of incidence.

The intensity of the light at a given angle is proportional to the density of rays at that angle. By measuring the intensity at the non-specular angles, we hope to be able to quantify the noise height of different samples.

1.2 Extreme ultraviolet

For our purposes, we define extreme ultraviolet (EUV) to be between 1 and 60 nm on the electromagnetic spectrum. One difficulty in using EUV arises because EUV radiation is absorbed very quickly in air. As a result, we do all of our measurements under vacuum. Though the EUV is difficult to study, it is a useful tool in many fields. Photolithography is the most common process by which computer chips are made. Because of diffraction, the size of the computer chips is limited by the wavelength of light used. Currently, visible and UV light can be used in photolithography. Using EUV light in photolithography would enable us to make even smaller computer chips. Another application of EUV light exists in astrophysics. Because different wavelengths illuminate different features of astrophysical objects, EUV observations are an important tool for learning about these objects. In particular, the EUV can be used to study transitions from singly ionized He and blackbody radiation from stellar interiors. Other applications of the EUV exist in medicine, microscopy, and plasma diagnostics.

Since the wavelength of EUV light is short compared with the characteristic features size on our chrome samples, we used geometrical optics to analyze our reflection data. We will eventually be able to detect surface roughness on a scale comparable to the wavelength of EUV light; however, in this paper we are using a simplified calculation to prove that this will be possible. We hope to eventually improve our

current methods of characterizing surface roughness through atomic force microscopy and electron microscopy.

2. Calculating non-specular reflection

Currently, we have measured reflection data from two black chrome samples provided to us by Lawrence Livermore National Laboratory. Their project is sensitive to EUV light and needed to minimize non-specular reflection from their surfaces [2]. The samples are different in surface roughness and were part of a project to compare surfacing techniques that would minimize non-specular reflection in the EUV. The measurements we will be discussing are from a sample that shows grooves that are approximately 18 μm in diameter and have additional roughness with a dominant spatial frequency of 0.3 to 0.4 μm^{-1}.
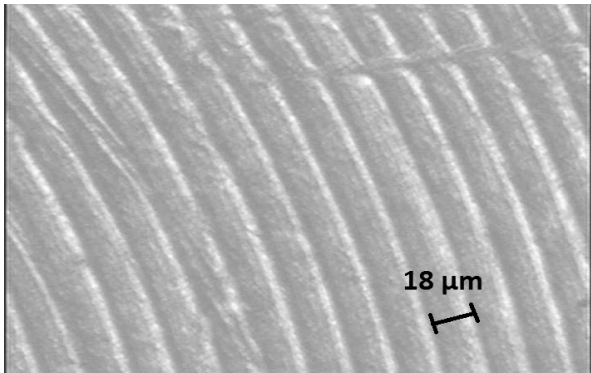
Fig. 3. Image of our chrome sample taken under a visible microscope to show the 18-μm grooves up close.

We used a vacuum chamber reflectometer to measure the non-specular reflection of EUV light. To do this, we created a monochromatic beam of EUV light using a hollow cathode light source, which uses a He plasma and a grazing-incidence monochromator. Our hollow cathode was designed after the source described in Paresce et al. [3]. This light is then directed into our vacuum chamber through a pinhole that is 0.3 ± 0.1 mm in diameter, which defines the beam. There is a sample stage in the center of the chamber 17.4 ± 0.2 cm from the pinhole that can be rotated as well as moved in all three directions. We took our measurements using a detector 15.3 ± 0.2 cm from the sample stage that can be rotated around the edges of the chamber. The detector

that we used is a channel electron multiplier and can detect single photons as they enter the entry aperture of 3.2 ± 0.5 mm diameter.
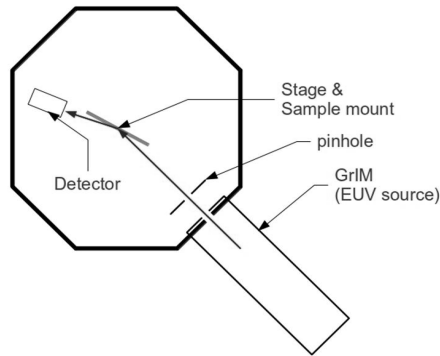
Fig. 4. Illustration of our vacuum chamber showing the detector, stage mount, pinhole, and hollow cathode with grazing-incidence monochromator.

We took several measurements to calculate the reflection from the sample as a function of angle. We measured the incident beam profile to normalize the reflection and compare the reflection measurements, the background noise that is in the chamber, and the random noise, or dark counts, that we got from our detector. To measure the beam profile, we moved the sample stage out of the path of the beam and scanned the detector across the beam to see the number of incident photons. The background measurement was taken when there was a beam in the chamber but it was not being reflected from the sample. The detector was scanned across the angles that we measured for the reflection to pick up the background EUV light that was in the chamber. The dark counts were measured by running the detector when there was no beam in the chamber. A typical dark count measurement from our detector is around 1 count per second. Finally, the reflection measurement was taken by scanning the detector from 0 to 90°, where 0° is the specular angle of reflection. Our detector has an angular acceptance of 1.2 ± 0.8° based on the size of the entry aperture and the distance from the sample to the detector.

3. Analysis

To calculate the reflection as a percentage of the incident beam, we took into account the fact that the light passes through a circular

hole before entering the detector and normalized it with the background, dark counts, and incident beam.
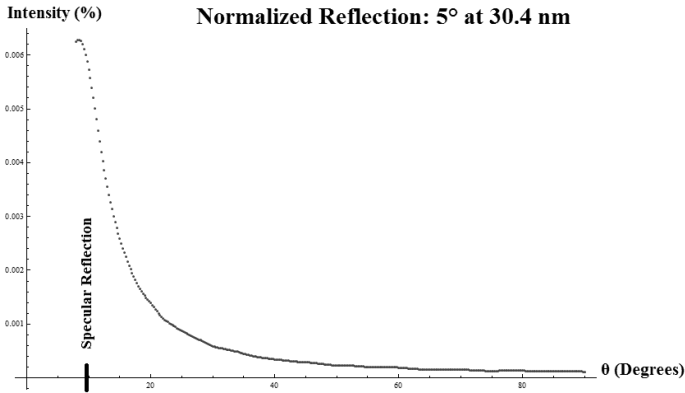
Fig. 5. Reflection data once normalization process has been completed. The y-axis is the percent intensity that is reflected at the given angle. In this case, the incident angle was 5°.

Since the light that we measured was the light from the incident beam that passes through a vertical slit and a circular aperture, we treated our measurements as a convolution of the two shapes. A convolution is a combination of the beam exiting a slit and the light through the circular aperture and its equation is given by equation (1) where $[f * g](\theta)$ is the convolution of f and g.

$$[f * g](\theta) = \int_{-\pi}^{\pi} f(\varphi)g(\theta = \varphi)d\varphi \qquad (1)$$

To then determine what the incident beam looked like before smearing, we performed a deconvolution of our measurement with the function we calculated for a slit of light passing through a circular aperture. We did this by utilizing the convolution theorem [4]. If $\hat{f}$ is the Fourier transform of f, then the convolution theorem states

$$\left(\widehat{f * g}\right) = \hat{f}\,\hat{g} \qquad (2)$$

Therefore, if the smeared beam is $h(\theta) = f * g$, then $\hat{h} = \hat{f}\,\hat{g}$ or $\hat{g} = \dfrac{\hat{h}}{\hat{f}}$. We were then able to solve for the incident beam g by performing an inverse Fourier transform of $\dfrac{\hat{h}}{\hat{f}}$.

We integrated the measurement for our incident beam to get the number of incident photons. Where the background was statistically significant it was also subtracted out. We then divided the reflection calculation by this to normalize it and get a percentage reflection as a function of angle.

3.1. Modeling surfaces and surface characteristics

To show that we are able to learn more about the surface features by looking at the reflectance data, we have modeled different surfaces and varied some surface parameters to match a calculated reflection with our measurements. Since the surface features on the sample are much larger than the wavelength of our light, we used geometrical optics to calculate the reflection for our model surfaces. Geometrical optics is the process of tracing a ray of light as it reflects from a surface. First, one assumes that the surface is locally planar. With this assumption, one can trace a ray of light using Snell's Law to determine the angle of reflection.

We explored four different models in our calculations. The first model used a cubic spline to interpolation between a Gaussian distribution of points within a set height and length (Fig. 6). The cutoff spatial frequency in this model was determined by the spacing between random surface heights; however, to better match the measurements taken on thin films by Rockwood [5], we decided to try a filtered model. To make a "filtered" distribution, we took a Gaussian model, whose points were more closely spaced than in the previous model, and cut out the high frequency noise (Fig. 7). We did this by doing a Fourier transform on the Gaussian model, multiplying it by a Gaussian function, and then doing the inverse Fourier transform. The third model we used was a $\sin^2$ function (Fig. 8) that more closely represented the image we saw of our sample but had no noise on top of the $\sin^2$ function. The last model was a $\sin^2$ function that has Gaussian noise on top of the $\sin^2$ (Fig. 9), which most closely resembled the image of our sample.
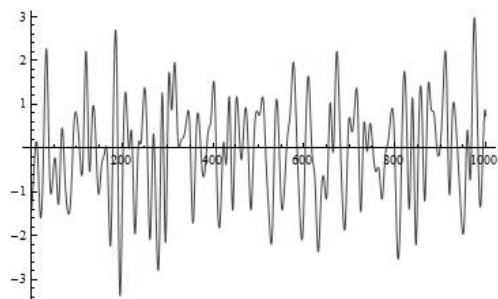
Fig. 6. Gaussian surface made by an interpolation between a random Gaussian set of points.
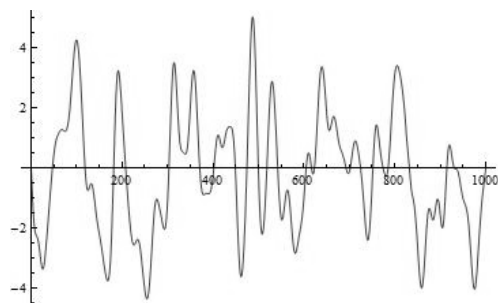
Fig. 7. Filtered Gaussian made by filtering out high frequency variations in the Gaussian surface.
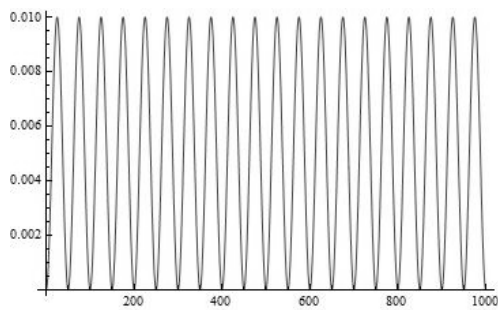
Fig. 8. Sin^2 surface, which does not include any noise on top of the sin^2.
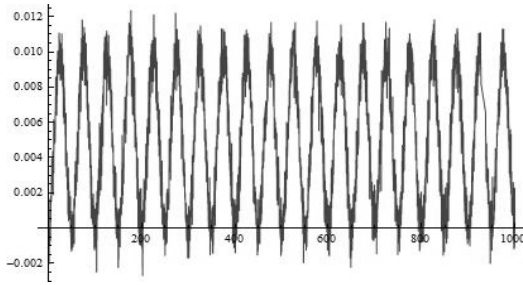
Fig. 9. Sin^2 with noise, which is made by putting noise on top of the sin^2 surface.

We chose to explore a periodic surface because the image we took of the surface appears periodic. However, as seen in Figure 10, the reflection calculation for a sin^2 function looked nothing like what we saw in the data so we quickly dismissed this surface and conclude that it is the noise and smaller surface features that contribute most to the reflection measurements.
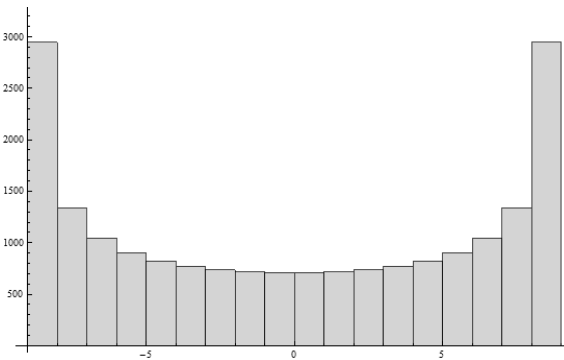
Fig. 10. Reflection data from sin^2 surface. This clearly does not match the reflection data that we see in Figure 5.

We then looked at what effect varying the parameters on our filtered Gaussian model had. We varied the number of points, the length of the surface, the height of the noise, and the standard deviation of our Gaussian cut-off. As we increased the number of points that made up our surface, we were able to increase the height of the reflection peaks intensity, although the general shape of the data stayed the same. As

we increased the length of the surface, the peak height stayed the same but the peak became narrower. As we increased the height of the noise, we noticed that the peak was most narrow at a specific value and then became less defined (more spread out) as you moved away from that value. The spread of values increased as the height of the noise increased. When the cutoff frequency was too low, the shape of the reflectance data was fairly random; however, at a specific value it began to take a Gaussian shape. As the cutoff frequency was increased, the peak spread out and became less defined and the range of values increased. The effect on our fitting data as we changed the noise height is illustrated in Figures 11 and 12.
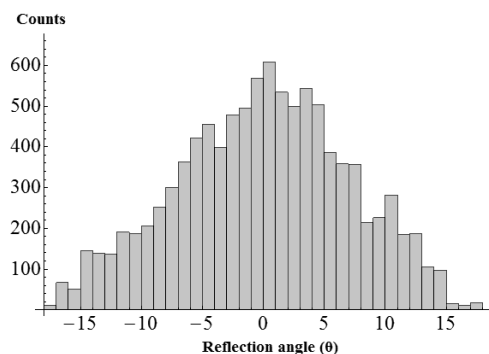
Fig. 11. Fitting data when noise height is set to 0.32 µm.
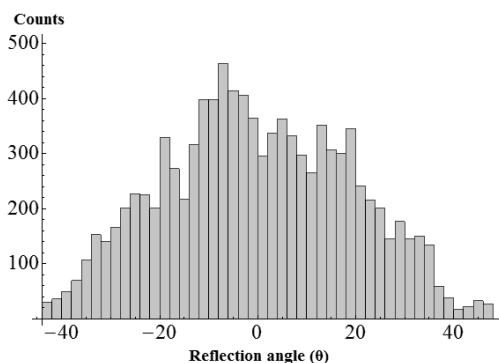
Fig. 12. Fitting data when noise height is raised to 0.96 µm. Notice how the peak decreased and the distribution of angles broadened.

We were able to show that we can vary the parameters and match the histogram of our calculated reflectance with the profile of our reflectance measurement (Figs. 13, 14 and 15). This proves that we are able to learn about the surface characteristics of samples by analyzing the non-specular reflection.
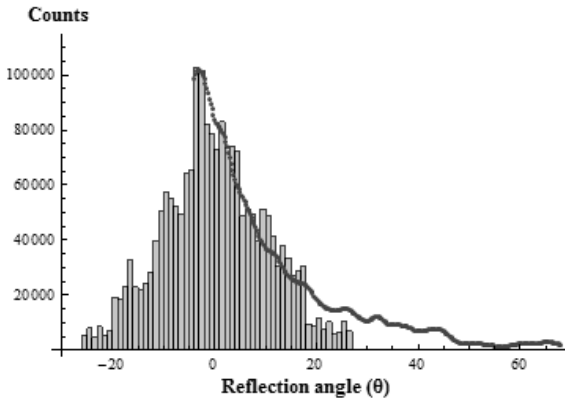
Fig. 13. Sample reflection data fitting. These are the reflection data taken from the chrome sample at 10° from 25.6 nm light. The bold blue curve is the actual reflection data and the blue histogram is the reflection data from our fitting model.
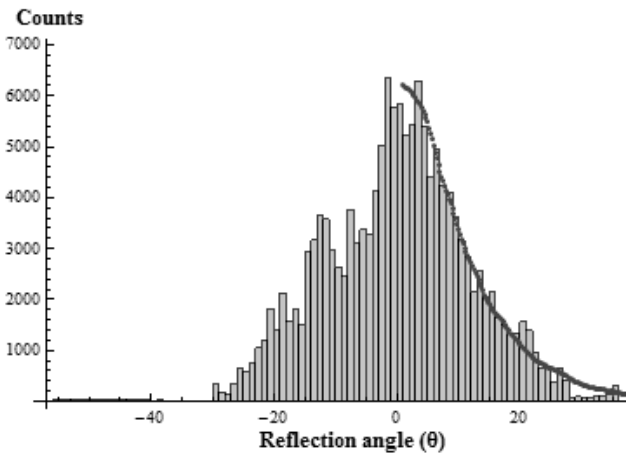
Fig. 14. These are the reflection data taken from the chrome sample at 10° from 30.4 nm light and fitted to the reflection curve from a modeled surface.
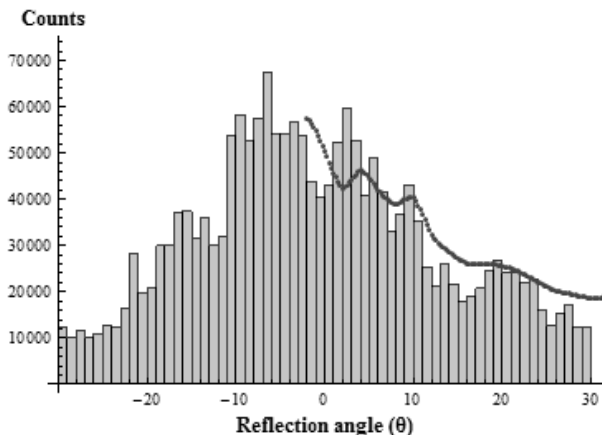
Fig. 15. These are the reflection data taken from the chrome sample at 20° from 30.4 nm light and fitted to the reflection curve from a modeled surface.

4. Conclusion

We have measured the non-specular reflection from chrome samples and have been able to fit the reflection data to the reflection data from model surfaces. Based on these models, we have determined that surfaces can be characterized based on non-specular reflection. We calculated the average noise height of chrome samples to within 1.1 ± 0.2 µm. While the resolution of this method was sensitive to the roughness on the 1.1-µm scale, we hope to eventually achieve better resolution than AFM. To do this, we will need to use the method described by Hart and Turley [1]. We determined that the non-specular reflection was more sensitive to smaller variations on surface height than to the much larger $\sin^2$ variations. This was determined because the fitting reflection data from the $\sin^2$ function (Fig. 10) alone looked nothing like our reflection data. Characterizing surface features based on non-specular reflection will allow for the design of more efficient and accurate optical equipment in the EUV.

5. Acknowledgments

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Technology Use in Higher Education Classrooms

Kerry Kennedy, Brett Bartruff, Gina Brewer, and Mary Byra
Weber State University

Abstract

This study addresses the impact personal technology has on face-to-face (lecture) college classes. Literature reviews show that more studies are investigating how students are using this new technology and whether it hinders or enriches education. The survey was based on what types of personal devices students use in the classroom setting, and how often they use their devices for non-educational use. Questions also asked whether the use of technology is distracting during class. The volunteers were students at Weber State University (WSU). The survey was sent through the university e-mail system. A 23-question survey asked the following: the student's field of study, whether their field of study required personal technology use in the classroom, the devices they own, their experience with these devices, how often they use these devices during a lecture, and how often they use them for non-educational purposes (e.g., Facebook, Twitter, personal email). Demographics include race/ethnicity, sex, age, and whether they are a traditional or non-traditional student based on WSU

guidelines. Other questions asked were grade point average (GPA) and class rank in school (freshman, sophomore, junior, senior). We found that the non-traditional students were distracted by their peers' texting during class, and there is a negative correlation between GPA and time spent on non-educational activities. Our findings show that qualitative studies can be conducted to further investigate technology use in the classroom.

Traditional university face-to-face, lecture, classroom environments are a shared experience among fellow students and professors. Each person's behavior interacts with the classroom environment and has a correlation to his or her own personal learning experience, as well as those of others in the collective experience. The variety of technological devices used in the classroom are continuously changing and are as diverse as the individuals that make up a class. The purpose of this study is to study the effects that the use of technological devices in the higher education classroom have on students' level of attention.

Literature Review

As we examine various articles, we found that a variety of research studies examined the relationship between technology and the distraction it poses on students' learning. Wood et al. (2012) examined the "…impact of off-task multi-tasking with technology on real-time classroom learning" and "…learning performance when… [engaged] in multi-tasking with digital technologies while attending real-time classroom lectures" (p. 365). Multitasking is defined as doing more than one task at a time, and by the type of multitasking—for example, non-competing tasks like listening to a lecture and note taking (verbal, motor) or competing tasks like listening to a lecture and typing a message (verbal/verbal task). In that study, 145 participants were assigned to different conditions: Facebook, texting, instant messaging, and email conditions. On the post-test, participants in the Facebook and MSN groups showed a significantly lower score on the test than those who used a paper and pencil. "…not all multi-tasking conditions yielded poorer performance than the traditional paper and pencil condition as predicted" (Wood et al., 2012, p. 369). This study is noteworthy because it shows the effect of non-educational use of technology and the effect it has on learning in a lecture-style classroom.

Similarly, Bowman et al. (2010) posed a question about students and multitasking. The authors hypothesized that multitasking interferes with the time it takes to complete a task as well as the ability to com-

prehend and remember the material. The study consisted of 89 college students, 46 men and 43 women. The participants' ages ranged from 17 to 46 years old with M=20.17 (SD=4.29). Of the students, 46% were in their first year of college, and 33% were in their second year. The students would read an academic passage and at the same time would receive instant messages (IMs) online. The results showed that "…those who IMed during reading took significantly longer to read the passage compared to those who IMed before reading…"(p. 930). The surprising results showed that the overall test performance was not affected even though recent correlational research has suggested there is an influence of "media multitasking and academic distractibility" (p. 930). This article shows the complexity of how technology use influences attention (multitasking) and that it is possible that different devices and different tasks will affect the students' level of attention during a lecture.

Wurst et al. (2008) conducted a comprehensive study on the basis that, "…a technological learning environment can alter the way students learn and the way professors teach" (p. 1766). One group had laptops and the other group did not have laptops; students in both groups take traditional and honors classes and must meet certain criteria to be in the honors program. The results showed that faculty reported that laptop use was mostly "…for individual work, projects, and e-communication." (Wurst et al., 2008, p. 1771) The laptops were rarely used during group work and realistic situations. Four out of 10 faculty members thought laptops changed the nature of their teaching and did make it more student-centered. In the activities that showed a significant difference, only one of them was a positive influence by ever-present laptop use. Further with regards to grade point average (GPA), the authors found these "…were higher for the laptop cohorts than for the non-laptop cohort, but not statistically significantly different…." (p. 1772). Student satisfaction was also measured after introducing laptops to the students. Results showed that those with laptops (n= 60) (M= 62.20, SD= .7.46) (p=.048) showed significantly less satisfaction with their education than those without a laptop (n=26) (M=65.80, SD=8.10). Students identified laptops as a distraction and found it difficult to control their temptation to do other activities on the internet, and in some cases, students became inattentive to the lectures. While this study was looking at the overall satisfaction, it found that laptop use in the classroom could cause significant distractions and make learning more difficult during a lecture (traditional) classroom. This study is conducive to our research in that laptops/tablets/iPads can create distractions and impair the students learning during a lecture.

Kay and Lauricella (2011) studied "…the impact of unstructured (limited use) vs. structured (active use) of laptops for 177 university

students" (p. 33). They outlined three options for higher education professors to deal with the use of laptop computers in the classroom by students: reject, ignore (unstructured use), or accept (structured use) laptops. Kay and Lauricella (2011) obtained a sample of higher education students, which included 89 men and 88 women (*n*=177). Participants represented all years of the undergraduate university and a variety of majors. Each student participant leased an IBM laptop with wireless Internet capabilities. Results showed that students used their laptops for on-task behaviors far more in classes that provided structured use as compared with an unstructured course. Also, students engaged in off-task behaviors significantly more in unstructured courses than in courses that provided structured use of laptops. This study directly highlights the effects that technology in the higher education classrooms can have on distracted learning. Interestingly, this study demonstrated that students may not intend to distract themselves from the educational material of a lecture, but when they have an opportunity to divert their focus, their attention suffers.

Junco and Cotten (2011) conducted a study to evaluate the effects that multitasking with instant messaging can have on academic performance. Their study utilized a web-based cross-sectional survey to determine whether instant messaging while completing academic activities had a detrimental effect on the student's educational outcomes. Researchers invited their participants from four public universities (*n*=4491). Results indicated that instant messaging while trying to complete course-related homework had an overwhelmingly detrimental effect. Of the student participants that reported that instant messaging had a detrimental effect on their schoolwork, 70% reported a harmful impact to their homework occurring very frequently. Women reported greater impairment at 60%, while men reported a detrimental effect 55% of the time. In regards to class standing, students in all four years reported a detrimental effect on schoolwork occurring at least 50% of the time, with sophomores having the greatest effect at over 60%. This study demonstrates the exact subject we are investigating: when students attempt to divide their attention with a current technology their academics suffer. While this study looked at the effect on attention of the individual user outside of the classroom, our study questions the outcomes inside the classroom on the individual user and other members sharing the same educational space.

Archer et al. (2011) looked into students' multitasking with electronics and whether it resulted in distracted behavior. There were 145 randomly selected students participating (116 women and 29 men). Students were assigned to engage in various off-task behaviors and were then quizzed to determine how well they retained the presented

material. The independent variables were the students and the various off-task behaviors. The dependent variable was how well they retained the information. The study showed that when students engaged in two or more tasks at the same time, it was disadvantageous to at least one of the tasks.

Fitch (2004) evaluated whether interactive technology in the classroom enhances the inclusion of student participation and understanding. The procedure for this survey had instructors utilize the Loan Star interactivity technology that allowed students to respond instantly and anonymously (Fitch, 2008). After completion of each class, the students were given electronic surveys to determine whether the use of the technology added to their understanding of the material. Analysis showed that students overwhelmingly felt the Loan Star program was effective in helping them comprehend the material. The study discovered that there were a few instances where the instructor was unfamiliar with the technology and times when the technology malfunctioned, so the lectures were not presented at all. In such instances, understanding of the material was completely absent because no information could be presented.

Fried (2008) discussed in-class laptop use and its effects on student learning as it is related to our study. Laptops are commonly used in higher education. This research examined the nature of in-class laptop use in a large lecture course, and it also examined how its use is related to student learning. All students were told at the beginning of the course that they could bring the laptops to class to take notes if they wanted to, but that they would never need laptops. Weekly surveys were completed on various aspects of the class, such as class attendance, classroom experiences, and laptop use (n=137). The findings of the study showed that 64.3% of students reported using their laptops in at least one class period, and those who used the laptops used them during 48.7% of the class periods on average. Users reported that they multitasked (did things other than take lecture notes) for an average of 17 minutes out of each 75-minute class period. A total of 81% reported that they checked email during the lectures, 68% reported that they used instant messaging, 43% reported surfing the net, 25% reported playing games, and 35% reported doing "other" activities (Fried, 2008). These findings show that while technology can be useful in the classroom, the majority of students spent some of their lecture time doing activities that can hinder learning the material

The article reviews can provide historical data as to what studies have been conducted and what researchers, experts, and educators think of this new technology that is infiltrating their classrooms. The aim of our study was to examine how technological devices affected level of

attention. We separated device use into personal use and that of another peer's use of technology in the traditional lecture classroom. We were specifically examining devices in two categories of laptop/tablets/iPads and cellular phones with text messaging capabilities. To examine the effects of technology on attention, we proposed four hypotheses.

> Hypothesis 1: The personal use of laptop/tablets/iPads has an effect on that individual user's level of attention.

> Hypothesis 2: The personal use of cellular phones to send text messages has an effect on that individual user's level of attention.

> Hypothesis 3: The use of laptop/tablet/iPads in the classroom by other students has an effect on the non-users level of attention.

> Hypothesis 4: The use of cellular phones to send text messages in a classroom by other students has an effect on the non-users level of attention.

Method

The participants were students at a large university (Weber State University) in the western United States. The study used a nonprobability convenience sample: subjects were contacted by mass university e-mail intermittently for a period of five days. Those students who wished to participate but did not qualify as part of the study were filtered by our first question: "Have you ever taken face-to-face (lecture) classes?" They were still eligible for the incentive because they took the time to participate in the survey. Our incentive was a drawing that awarded four $25.00 gift cards.

Variables

Independent variables in this study were the individual respondents, their personal demographic information, whether they had had traditional lecture face-to-face classes, their selected field/major of study, their personal use/ownership of personal technological devices, and their level of experience with their devices. Other independent variables were how much they personally use, or witness others using, technological devices in their traditional face-to-face lecture classes,

and whether they are required by their major to utilize technological devices. Dependent variables were whether their or other's use of these devices distracted their attention from the material presented during lecture. Dependent variables were measured through a series of questions concerning students' level of attention, as well as students' GPA. The variables were chosen to highlight whether they specifically relate to the level of attention correlated to the use of technological devices in the traditional face-to-face lecture setting.

Based on the level of measurement, the most appropriate analysis for this study is quantitative. Nominal levels of measurements were utilized to express results that are categorical only, such as the respondent's personal demographics, whether they have attended traditional face-to-face lecture classes, their field of study/major, and what type of technological devices they own. Ordinal and interval levels of measurement were used to express responses that could be ranked by degree, such as the respondent's level of attendance of face-to-face lecture classes, their competence with personal technological devices, the percent of time they use technological devices in the classroom, how often they witness other students in the classroom using technological devices, and the degree of impact their and other's use of devices has on their level of attention.

Design

Our design is a cross-sectional study. This type of design is intended to take an observation of a single point in time as compared with a longitudinal experiment. We were unable to locate an existing instrument that measured the variables we were wanted investigate. We identified our variables and formulated questions for the instrument that would highlight the appropriate information. The instrument scored each response individually. We tested the reliability by having a control group test the instrument before it was implemented. Initial results showed that the instrument had validity because its responses indicated the desired information. Limitations and threats to the validity are inherent in the cross-sectional design because the validity it has is only face validity.

Statistical Analysis

Our research study consisted of $N=370$ participants. Eight students were removed because they had not taken face-to-face classes and they would not be able to answer the survey accurately. This left us with data for 362 participants in the final sample. The analysis sample was made up of $n=107$ (29.6%) freshman, $n=71$ (19.6%) sopho-

mores, *n*=88 (24.3%) juniors, *n*=79 (21.8%) seniors, and *n*=17 (4.7%) post-graduates. Over half (52.2%) of the sample identified themselves as non-traditional students (*n*=189); this reflects previous data describing the student body at Weber State University. The analysis sample had a GPA ranging from .99 to 4.0, with a mean GPA of 3.29 (*SD*=.51). The analysis sample's age range is 17 to 59, with a mean age of 26.7 (*SD* =8.80). The most common field of study was the social and behavioral sciences. The demographics of the results show 97 males (26.8%) and 265 females (73.2%) took the survey. Because the majority of our sample identified themselves as Caucasian, we recoded race/ethnicity as "Caucasian" 85.9% (*n*=311), "Other" 10.2% (*n*=37), and "Prefer not to answer" 3.9% (*n*=14). Previous data show that approximately half the student body at Weber State University is considered non-traditional students. Table 1.1 details the entire analysis sample's field of study. One respondent in the sample analysis did not indicate what their field of study was.

Table 1. Analysis Sample Demographics		
Characteristic	**n**	**%**
Race		
Caucasian	311	85.9
Non-Caucasian	37	10.2
Major		
College of Applied Science & Technology	31	8.56
College of Arts and Humanities	29	8.01
College of Education	44	12.2
College of Health Professions	81	22.4
College of Social and Behavioral Sciences	133	36.7
School of Business & Economics	30	8.28
Interdisciplinary Studies	12	3.31

Demographics

To understand the sample's relationship to technology and their experiences with it, the survey tool identified various demographic characteristics. Only 23% (*n*=83) were required by their major to use technology, with one individual choosing not to respond to the ques-

tion. In relation to their level of experience with technology, 5.3% (*n=19*) identified as beginner, 28.9% (*n=104*) as intermediate, 57.1% (*n=205*) as experienced, and 8.9% (*n=32*) as expert. The number of devices owned by individuals in the sample varied, with .8% (*n=3*) owning zero, 10.2% (*n=37*) owning one, 52.8% (*n=191*) owning two, 29.8% (*n=108*) owning three, and 6.1% (*n=22*) owning at least four devices. The type of devices identified by the survey included laptop, iPad/tablet, eReader, smartphone, basic cell phone, iPod touch, and other. Our survey tool did not have a category for the iPod touch, but because so many of them showed up in our "other" section, we recoded our data to create a separate category. Table 2 details the frequency and percentage of each device category

.

Table 2. Technology Demographics		
Device	***n***	**%**
Laptop	324	89.5
iPad/Tablet	61	16.9
eReader	63	17.4
Smart Phone	193	53.3
Basic Cell Phone	162	44.8
iPod Touch	15	4.14
Other	15	4.14
None	3	.083

Initial results showed how often devices are used in the classroom, how often students use devices in the classroom, how often they witness others using devices in the classroom, how much time students spend using devices for noneducational purposes, and the effect that the use of devices has on students' level of attention. Responses indicated that only 30.9% (*n=112*) do not use personal devices in the classroom, while the rest used devices at least a little during face-to-face lectures. An overwhelming majority (70.2%) of responses indicated that time spent using devices was for educational use. Most (68.2%) students responded that they do not text during class. A majority of students indicated that use of devices (*n=249*, 68.8%) or texting (*n=224*, 61.9%) by others has some effect on their level of attention.

Significant Correlations

We used GPA as an indicator of lack of attention when using personal devices. A significance relationship between a student's GPA

and time spent on personal devices for noneducational use was found (Kendall's *tau-b*=-.184, p=.000). The findings show that the more time spent using devices for noneducational use in the classroom, the lower a student's GPA, supporting Hypothesis 1 that personal use of technological devices has an effect on level of attention. This finding is not supported by Wurst et al. (2008), as they did not find a statistically significant difference when looking at GPA among laptop and non-laptop users.

The university's unique demographics allow for a look at various correlations between groups within the analysis sample. There is significant relationship between type of student (traditional and non-traditional) and time spent texting in class (*Phi* = .228, p = .001). More traditional students spent time texting in class, with 43% spending at least a quarter of their time texting during class. Only 22.3% of non-traditional students spent a quarter or more of class time texting. A significant relationship was also found between type of student and how other students' texting had an effect on their level of attention (*Phi*=.191, *p*=.01), supporting Hypothesis 4. Non-traditional students' level of attention was affected 64% of the time compared with traditional students at 59.5%. No other significant relationships between traditional and non-traditional students were identified.

Significance was also noted between how often a student used personal devices and how greatly other students' use of personal devices had an effect on their attention (Kendall's *tau-b*=-.152, *P*=.001), which speaks to our Hypothesis 3 that other students' use of devices has an effect on the non-users level of attention. Also, the relationship between how often a student used personal devices and how impactful other students' texting was to their attention was also significant (Kendall's *tau-b*=-.138, p=.002), supporting Hypothesis 4. These last two relationships seem to show that the more time students spent using use their own personal devices, the less they are affected by other students' use of them. It can be inferred that a student's attention is already being impacted by the use of his or her own device.

A significant difference relating to gender was identified when comparing how often personal devices are used in the classroom (*Phi*=.165, *p*=.043). Men had the higher percentage of use of personal devices, with 76.3% using personal devices at least a little during lectures. Only 66.4% of women used personal devices in class for any amount of time. A significant difference was also found between gender and how other students' use of personal devices affects attention (*Phi*=.204, *p*=.004). Women indicated they are more affected by others' use of personal devices, which is similar to Junco and Cotten's

(2011) findings. Table 3 illustrates significant correlations found in the analysis.

Limitations

One limitation of the study is the limited amount of time that was available for it to be completed. By the time data were collected, there were only a couple of weeks left to analyze it. Another limitation could also be the large percentage of the population represented by women.

Table 3. Correlations Between Variables		
Variables	**Statistic**	***P* Value**
Traditional vs. non-traditional student and time spent texting during class	*Phi* = .228	.00*
Traditional vs. non-traditional student and how much effect other students' texting has on level of attention	*Phi* = .191	.01*
Female vs. male and time spent using personal devices in the classroom	*Phi* = .165	.04*
Female vs. male and how much effect others' use of personal devices has on level of attention	*Phi* = .204	.00*
Students' GPA and time spent on non-educational use	Kendall's *tau-b* = -.184,	.00*
Student's use of personal devices and how much effect others' use of personal devices has on level of attention	Kendall's *tau-b* = -.152	.00*
Student's use of personal devices and how much effect others' texting has on level of attention	Kendall's *tau-b* = -.138	.00*

*Indicates a significant p value of ≤.05.

The email invitation could only be sent out once because time con-straints did not allow for additional mailings and follow-ups. Technical problems prevented invitations from being sent to the entire student body of the university. Only a small percentage of students responded, in comparison to the large amount of invitations sent out. Our survey

only allowed for surface, superficial responses that prevented a more in-depth analysis.

Conclusion

There were similarities between our study and the findings from the literature we reviewed. For example, the more students used their laptops in class, the lower their class performance. In our results, there was a negative correlation between GPA and non-educational uses of technology. The literature review also considered distractions in the classroom. Another study found that laptops were the most distracting devices, and we thought we would see similar results. Instead, we found that non-traditional students were more distracted by texting. It is important to note that the majority of students had some level of distraction in regards to technology use in the classroom. There will always be benefits and risks associated with personal use of technological devices in the classroom. Qualitative and quantitative studies will continue to be done as technology devices begin to be the standard. Only time will tell how effective the use of these devices will be and whether they will be an asset to the educational process or if they will hinder and distract learning.

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Shared Promise: The Rhetoric of Presidents Bush and Obama

Luke Perry
Utica College

Abstract

Scholars have begun to evaluate the Obama presidency and draw comparisons with Obama's predecessor, George W. Bush, yet there has been little examination of the rhetoric employed by each. This research examined the following question: How does the presidential rhetoric of Barack Obama compare with that of his predecessor, George W. Bush? Though one may expect variance to be the dominant pattern, this article examined the thesis that Presidents Bush and Obama used similar rhetorical frameworks in articulating their candidacies for president. To evaluate this thesis comparative analysis was undertaken of each candidate's acceptance speech at their party's national convention. This research is important in promoting greater comparative analysis of the rhetorics of Obama and Bush and enhancing interpretations of each president's use of political rhetoric.

The Transition of Power

The Republican Party entered the 2008 election with many short-comings, including the federal response to Hurricane Katrina, uncon-trolled government spending, and record high deficits (Cook 2009). Bush administration policies provided the storyline of the election, par-ticularly the deterioration of the economy, the war on terror, and the expansion of executive powers. This transformative context set the agenda for the election and determined the outcome. Obama was the candidate committed to change in contrast to John McCain, who was committed to continuing Bush's policies (Crotty 2009). After Obama's landslide victory, Bush actively engaged in unprecedented transition planning that resulted in a high level of cooperation between the outgo-ing and incoming administrations (Kumar 2009).

Although criticism of the Bush administration was an important component of Obama's rhetorical campaign, the first two years of Obama's presidency produced several policy alignments with the pre-vious administration. These included the surge in Afghanistan, modeled after American efforts in Iraq, the extension of the Bush tax cuts, Guan-tanamo Bay remaining open, and the continued use of military tribunals to prosecute suspected terrorists. Identifying limited policy continuities between Bush and Obama is not to suggest widespread ideological co-hesion. Rather, the sharp contrast between the two presidents may not be as rigid as originally anticipated.

Policy analysis of continuity and change is to be expected with a transition from a two-term Republican administration to a new Democ-ratic administration. This study is focused on the degree of continuity and variance among the larger rhetorical frameworks employed by Presidents Bush and Obama to articulate their political visions and craft their political image. Past studies on the image and rhetoric of these two presidents have taken various forms. Homolar-Riechmann (2009) documented the continuing influence of neo-conservatism over framing subsequent American foreign policy debates during the Obama presi-dency, particularly in terms of establishing a moral purpose for the use of American power. In contrast, Quelch and Jocz (2009) examined the precipitous decline of America's image as a positive global leader un-der the Bush presidency and the related opportunity for Obama to res-urrect America's global image. In regard to domestic politics, Ford et al. (2010) examined how Obama can effectively address racial ine-qualities as his black constituents expect, after running a racial neutral campaign that maximized appeal with white voters. Vaughn and Vil-labos (2009) examined how Obama can effectively overcome the lead-ership challenges associated with the imagery of a "war on science"

accompanying science and technology policy making under the Bush administration.

This research examined the rhetoric and imagery employed in a vitally important speech, the acceptance speech of the candidate's party nomination. This speech was viewed as a valuable opportunity to gain pertinent insights into how the presidents viewed and articulated their candidacies. The following sections will discuss the nomination speeches of Bush and Obama in detail prior to identifying and comparing relevant rhetorical approaches and frameworks.

George W. Bush's Nomination Speech

Bush began by stating that "together we will renew America's purpose." Bush used reflections on love and admiration for his father to provide the foundation for a larger discussion of generational change in America. George H.W. Bush was the last president of a generation who made great sacrifices that "delivered us from evil." The question before the nation in 2000 was: "What is asked of us?" The "promise of prosperity" had never been so vivid. Bush vowed to "seize this moment of American promise" and "use these good times for great goals." Hard issues would be confronted, such as national security, health security, and retirement security. The "promise of prosperity" would be extended to "every forgotten corner of this country" to give "every man and woman, a chance to succeed," every child "a chance to learn," and "every family, a chance to live with dignity and hope." The country had "coasted through prosperity" in the eight years under the Clinton–Gore administration. The promise was there, but not the purpose. The presidential leadership of Presidents Reagan and G.H.W. Bush during the Cold War was a high point of American power and influence in the world. Since then, America's position in the world had fallen and American military capability and readiness called into question. Bush sought to fuse promise with purpose and resurrect America's power and influence. To emphasize this point, Bush regularly interjected the following phrase after each of his substantive points: "They had their chance. They have not led. We will." Bush pledged to write chapters of the American story, not footnotes.

Bush directly addressed America's seniors by vowing to save Social Security and make prescription drugs widely available. This would fulfill the current generation's obligation to America's "greatest generation" and, in a larger sense, constituted a reflection of America's values, in taking care of those who came before and making the country better than it was inherited. Bush stated that some believed that the "growing federal surplus means Washington has more money to

spend." This was "backwards" according to Bush, who concluded that "the surplus is the people's money," not the government's money. Bush vowed to bring "common sense" and "fairness" in pursuing tax relief and pledged to abolish "the death tax." No American should have to pay more than one-third of their income in federal taxes, and those most in need should receive the most help. The bottom tax rate should be lowered from 15% to 10%, and the child tax credit should be doubled.

Bush spoke critically of President Clinton's approach to being commander in chief, although Clinton was not mentioned by name. Bush pledged to "give our military the means to keep the peace" and "a commander-in-chief who respects our men and women in uniform and a commander-in-chief who earns their respect." The generation that was shaped by Vietnam "must remember the lessons of Vietnam: when America uses force in the world, the cause must be just, the goal must be clear, and the victory must be overwhelming." In looking forward, America must defend the American people, "not outdated treaties."

Bush responded to the criticisms of his opponent, which were characterized as "the policy of the roadblock" and "the philosophy of the stop sign." Al Gore was mocked for describing one of Bush's views as a "risky truth scheme." Bush applied the phrase to great moments of discovery, such as the first rocket launch and the development of the light bulb. Bush suggested that Gore would describe these events as a "risky rocket launch" and a "risky anti-candle scheme," respectively. Bush then mentioned that "if he was there when the Internet was invented . . ." The sentence tailed off to laughter. Gore was not fit to lead the party of Franklin Roosevelt because all he had to offer was fear, and he held the typical outlook in Washington, described by Bush as "always seeing the tunnel at the end of the light."

Bush's experiences growing up in Midland, Texas, were put forth as important and formative experiences in understanding America's basic values of hard work, opportunities for self-improvement, a sense of community, and appreciation of basic equality that accompanies religious belief. The motto of Midland was "the sky is the limit," and "we believed it." Churches reminded community members that "every soul is equal in value and equal in need." The outlook on life was "optimistic, impatient without pretense" and "confident that people can chart their own course in life." Bush acknowledged that he "may lack the polish of Washington," but this was a good thing because he also did not have enemies to fight or a stake in existing disputes. Bush sought to "change the tone of Washington to one of civility and respect." Equality was the largest lesson Bush learned in Midland. This

equality was understood as an equal claim to America's promise from immigrants to entrepreneurs.

Bush discussed his experiences as governor with Texans who were struggling with the law or having a basic means to support themselves. These people, as Bush put it, believed they were "trapped," "worthless," and "hopeless." These perceptions are divisive in American society because they create a wall between "wealth, technology, education and ambition" and "poverty and prison, addiction and despair." Bush vowed to tear down that wall by applying conservative values and ideas to the fight for justice and opportunity.

Bush recalled a visit to a juvenile jail where a 15-year-old boy asked of the governor, "What do you think of me?" Bush stated in his speech that "He seemed to be asking, like many Americans who struggle… 'Is there hope for me? Do I have a chance?' And, frankly, 'Do you, a white man in a suit, really care about what happens to me?'" The boy's voice was small, but spoke for many Americans, including single mothers struggling to support themselves, immigrants trying to make it in a new country, and children without fathers. Bush stated that "we are their country, too. And each of us must share in its promise, or the promise is diminished for all."

Bush argued that this understanding of "compassionate conservatism" should serve as a foundation for leadership. "Big government" is not the answer because this replaces one bureaucracy with another. Governments "can feed the body," but governments "cannot reach the soul." Government indifference is not the answer either. Bush made clear that if granted the opportunity to become president, his decisions would be guided by conviction, rather than polls. "When I act," Bush stated, "you will know my reasons and when I speak, you will know my heart." Bush differentiated between something old, Democratic politics, and something new, the Republican alternative. The Republicans "are now the party of ideas and innovation, the party of idealism and inclusion, the party of simple and powerful hope." The elevation of Bush and his vision of leadership into the office of the presidency were portrayed as a born-again experience. "We can begin again. After all of the shouting and all of the scandal. After all of the bitterness and broken faith. We can begin again." The speech closed with insights and inspirational phrases peppered with the chorus of "it won't be long now."

Barack Obama's Nomination Speech

Obama opened his nomination speech by mentioning his 2004 speech at the Democratic National Convention and the sharing of his

story of "the brief union between a young man from Kenya and a young woman from Kansas who weren't well-off or well-known, but shared a belief that in America, their son could achieve whatever he put his mind to." This "promise" set America apart from other countries, in that each American can pursue his or her individual dreams and with hard work and sacrifice be in a position to achieve them. Even though these individual ambitions create differences throughout society, Americans remain united as one "family" dedicated to ensuring future generations have the same opportunities experienced by this generation.

Obama claimed that the nation faced a "defining moment," because of war and economic turmoil that threatened "the promise." The blame for these challenges was put squarely on the "broken politics in Washington" and the "failed policies of George W. Bush." Obama argued that America was better than the last eight years and used three specific examples to support this position. Obama, like Bush, appealed to compassion in his acceptance speech, claiming that we are more compassionate than a government that would let these things happen. This use of rhetoric simultaneously validated Bush's focus on compassion, yet called into direct question Bush's willingness to live up to his stated ideals.

Obama stated that Democrats "love this country too much to let the next four years look just like the last eight." John McCain was extended respect for his military and political record, but the image of McCain as an independently minded maverick was called into question through a voting record that aligned with the Bush administration 90% of the time. Particular attention was paid to the comment of a McCain economic advisor who called Americans "a nation of whiners" suffering a "mental recession." Obama cast himself as the candidate who better understood the economic anxiety felt by Americans. The problem was not that McCain did not care about Americans. Rather, McCain "doesn't get it" because he believes in "an old, discredited Republican philosophy," which proposes to "give more and more to those with the most and hope that prosperity trickles down to everyone else." What the "ownership society," as labeled by Washington, really means is that "you're on your own." Even if you are born into poverty, Obama stated, you are expected to "pull yourself up by your own bootstraps even if you don't have bootstraps." Obama sought to demonstrate a contrast between Democrats and Republicans about how each understand progress. Democrats understand progress as Americans at large enhancing their quality of lives through increased employment and educational opportunities. Republicans were portrayed as measuring progress through how many billionaires there are and the profits of Fortune 500 companies.

Obama then attempted to bridge left and right ideologies. The market should reward innovation, but American businesses should fulfill their duty to create American jobs and hire American workers. Government is unable to solve all society's problems, but it should when individuals are unable, in areas such as security, education, infrastructure, and regulation of unsafe business practices. America "rise[s] and fall[s] as one nation," not as individuals, and should remain dedicated to "the fundamental belief that I am my brother's keeper, I am my sister's keeper." Obama argued that "fulfilling America's promise will require more than just money." This "will require a renewed sense of responsibility from each of us to recover what John F. Kennedy called our 'intellectual and moral strength.'"

The responsibility portion of "the promise" has a democratic component, where Americans "can find the strength and grace to bridge divides and unite in common effort." Obama discussed several controversial issues, including abortion, gun ownership, same-sex marriage, and immigration. For each issue, commonalities between varying sides were identified. For example, Obama stated that Americans "may not agree on abortion, but surely we can agree on reducing the number of unwanted pregnancies in this country." Obama acknowledged that some view such rhetoric as "happy talk" out of the belief that "our insistence on something larger, something firmer and more honest in our public life is just a Trojan horse for higher taxes and the abandonment of traditional values." Obama responded by saying this was to be expected, "if you don't have any fresh ideas" or a record worth running on, "then you use stale tactics to scare voters."

Obama portrayed himself on the side of the American people, not previous Washington leaders, by acknowledging that he was "not the likeliest candidate for this office" because he did not "fit the typical pedigree" and had not spent his life in government. Obama claimed that something was stirring in America that strongly called out for change. In turn, the election was about "you," not "me." "Change happens because the American people demand it" and insist on new leadership and new politics. The American promise pushes Americans forward even during uncertain times and "binds us together in spite of our differences; that makes us fix our eye not on what is seen, but what is unseen, that better place around the bend."

The promise is the great inheritance of the next generation. "It's a promise that I make to my daughters when I tuck them in at night and a promise that you make to yours—a promise that has led immigrants to cross oceans and pioneers to travel west; a promise that led workers to picket lines, and women to reach for the ballot." Obama referenced that 45 years to the day this promise also inspired people to fill the Mall in

Washington to listen to the dream of Martin Luther King Jr. Although King was not mentioned by name, Obama coupled the conception of his dream with the imagery of marching to conclude that turning back from the challenges that faced Americans in 2008 was not an option. America must march forward rededicated to the American promise.

Comparing Bush and Obama

There were several similarities in the rhetorical approaches undertaken by each candidate. Both speeches emphasized how the previous administration had its chance and failed to make positive change. In 2000, this was evident in how Bush prompted the chant: "They had their chance. They have not led. We will." The candidate interjected specific failures of leadership between audience participation and applause. This climaxed in Bush's statement that "And now they come asking for another chance, another shot. Our answer? Not this time, not this year. This is not the time for third chances; it is the time for new beginnings." In 2008, Obama used a similar rhetorical approach in portraying the Republican platform as a broken ideology the failure of which was fully realized in the eight years of the Bush administration. The passionate close of Obama's speech echoed Bush's sentiments by quoting Martin Luther King Jr., who preached "we cannot walk alone . . . we shall always march ahead. We cannot turn back." Obama invited his audience to keep the American promise and "in the words of Scripture hold firmly, without wavering, to the hope that we confess."

This framework of missed chances and failure was built upon by both candidates in presenting their specific understandings of the opposition and seeking to discredit them. Bush was particularly critical of his predecessor in regard to commanding the military and foreign policy. Criticisms of Bush's opponent Al Gore were more personal than political. Bush criticized specific statements made by Gore, including the phrase "risky truth scheme." This specific phrase was used to develop larger negative characterizations of his opponent as someone who subscribed to "the philosophy of the roadblock" and "the philosophy of the stop sign." Bush concluded that Gore was not fit to be leader of the Democratic Party, let alone the nation. Obama's criticisms focused on larger philosophies as well as specific individuals. Obama portrayed the Republican philosophy as old and discredited. Republicans give to the rich and hope prosperity trickles down to the rest. What the "ownership society" really means is that people are on their own, even if they are born into poverty. Similar to Bush, Obama emphasized certain phrases made by McCain's advisors, such as Americans are "a nation of whiners" suffering a "mental recession." Appeals to economic populism

were particularly prevalent in these criticisms of McCain. Obama cast himself as the candidate who better understood the economic anxiety felt by Americans, while McCain was cast as a candidate who was out of touch with the American people.

Bush and Obama both focused on the notion of promise and articulated remarkably similar conceptions of this theme. Bush's understanding of American promise focused on the mixture of courage and character. By believing in certain values, such as hard work, faith, and humility, self-improvement and upward social mobility could be achieved by all. Obama's understanding of "the promise" was multi-faceted. At the core was the prospect that each American is able to achieve his or her individual dreams through hard work and sacrifice. Bush stated that everyone must share in the American promise or it will be diminished for all. Similarly, Obama stated that irrespective of different ambitions within our society, the nation must remain united as one family dedicated to ensuring the opportunities afforded this generation are passed on to the next. This common theme, which was the central theme of Obama's speech, is remarkable considering Obama's criticism of several aspects of the Bush presidency and his larger argument that Republicans do not understand America. The theme is equally remarkable in considering Republican criticism of Obama's emphasis on "hope" and "change" as being overly idealistic and lacking substance, when direct parallels can be drawn to Bush's acceptance speech.

Both presidential candidates characterized themselves as someone who truly understood American greatness. Bush stated that "the rising generations of this country have our own appointment with greatness." This greatness "does not rise or fall with the stock market" and "cannot be bought with our wealth." Rather, "greatness is found when American character and American courage overcome American challenges." Similarly, Obama stated that America has more wealth and military power than any other country, but that is not what makes America rich or strong. Rather, America's greatness is primarily defined by the opportunity Americans have to pursue their dreams and with hard work and sacrifice be in a position to achieve them. Both candidates sought to move conceptions of American greatness away from both hard and soft power toward themes of character, courage, hard work, and sacrifice.

Both candidates put forth their upbringing as an important component of their candidacy. Bush discussed his upbringing in Texas. Hope and equality were central themes in these appeals. Midland's motto was the "sky was the limit," people believed this, and as a result worked hard and sought to better themselves. Each person, regardless

of small individual differences, had equal claim to America's promise, because all people are equal before God. Bush downplayed the wealth and political prominence of his father and instead emphasized his lack of polish. This was put forth as a good thing, which most people could relate to, because, like them, Bush was a simple man who shared their values and perspectives, not the values and perspectives of Washington. The image of "George W" the Texas rancher was a sharp contrast to Connecticut born, Ivy Leaguer, George Bush Jr., who was born into a politically and economically elite family.

Obama first mentioned his childhood early in the acceptance speech by referencing his 2004 speech at the Democratic National Convention. The image of Obama's biracial background was mentioned later in the 2008 speech when Obama observed how he was "not the likeliest candidate for this office" because he did not "fit the typical pedigree" and had not spent his life in government. Rather than overtly asserting that his uniqueness was a strength or qualification, Obama claimed that something was stirring among the populace, in particular, a strong desire for change. The election was characterized as an event fundamentally about "you," meaning his supporters, rather than "me," the candidate. Both candidates sought to connect with America at large through the stories of their upbringing, but Bush used this narrative to connect with supporters and potential voters, whereas Obama sought to step back from the personal accolades of potentially becoming the first African-American president.

Both presidential candidates sought to elevate the tone of political discourse and bring together people of different political ideologies. Bush hoped to "change the tone of Washington to one of civility and respect." Obama linked this notion to the larger theme of "the promise." The democratic component of the promise is how Americans "can find the strength and grace to bridge divides and unite in common effort." Both candidates mentioned controversial issues and specific points of agreement that could be identified. One example was abortion. Bush stated that he would "lead our nation toward a culture that values life," including the young, old, and unborn. "Good people can disagree on this issue," Bush explained, "but surely we can agree on ways to value life by promoting adoption, parental notification." Similarly, Obama stated that Americans "may not agree on abortion, but surely we can agree on reducing the number of unwanted pregnancies in this country."

Bush viewed fear as an impediment to bipartisanship and stated it was time "for Republicans and Democrats to end the politics of fear." Obama spoke in more detail about how critics would view appeals for bipartisanship. Such claims would be dismissed as "happy talk" out of

the belief that "our insistence on something larger, something firmer, and more honest in our public life is just a Trojan horse for higher taxes and the abandonment of traditional values." Interestingly, Obama responded to this in a critical and arguably partisan manner, stating that "if you don't have any fresh ideas" or a record worth running on, "then you use stale tactics to scare voters." In turn, Obama simultaneously called for bipartisan cooperation and launched partisan attacks. Bush's attacks were more personal and policy oriented. There were no explicit references to the larger attitudes and beliefs of the opposition party.

Both candidates emphasized the notions of hope and change in their acceptance speeches. Bush recalled a visit to a juvenile jail as Governor where a 15-year-old boy asked "What do you think of me?" Bush took this question as emblematic of larger questions asked by struggling Americans who wondered if there was hope, whether they had a chance for self-improvement, and whether people in power really cared what happens to them. Bush vowed to tear down the wall between those who feel hopeless in poverty, prison, addiction or despair and those who have wealth, education, ambition and access to technology. America is a diverse country, but "each of us must share in its promise or the promise is diminished for all." Political leaders identify political goals inspired by "great hope" for this country and work to "usher in an era of responsibility." "It's a promise that I make to my daughters when I tuck them in at night," Obama explained, "and a promise that you make to yours—a promise that has led immigrants to cross oceans and pioneers to travel west; a promise that led workers to picket lines, and women to reach for the ballot." Interestingly, both Bush and Obama mentioned parenthood and immigrants in discussing their respective conceptions of hope. Whereas Bush used the theme of hope to rethink the role of government in society, Obama linked the notion of change to hope. "Change happens because the American people demand it," Obama explained, as Americans insist on new leadership and new politics. Obama used his personal experiences as a form of validation for change; he has "lived it" and "seen it" in countless ways. The American promise pushes Americans forward even during uncertain times and "binds us together in spite of our differences; that makes us fix our eye not on what is seen, but what is unseen, that better place around the bend." This promise is the great inheritance of the next generation.

Conclusion

This research examined commonalities in the presidential rhetoric of Presidents Bush and Obama. Comparative rhetorical analysis of re-

spective party nomination speeches illuminated that the rhetorics of Presidents Bush and Obama share many prominent similarities. Rhetorical similarities included: 1) a shared emphasis on the failures of the previous administration; 2) a shared focus on the notion of promise articulated in a remarkable similar manner; 3) a shared personification of themselves as true knowers of American greatness; 4) a shared emphasis on their personal backgrounds; 5) a shared pledge to elevate political discourse; 6) a shared emphasis on the notions of hope and change; and 7) a shared utilization of populist appeals. Future research would benefit this work by examining the inaugural addresses and State of the Union addresses to determine whether the findings uncovered here persist. This research is important in correcting and clarifying conventional interpretations of the presidential rhetoric of Barack Obama and George W. Bush.

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Fulfilling the Social Contract: Conflict Between Society and Combat Veterans

Roger Johnston
> *University of Southern California and University of Utah*

Daniel Poole
> *University of Utah*

Abstract

This descriptive study explores whether there is a conflict of values occurring in society from the perspective of combat veterans. Based on the narratives of soldiers exposed to combat, there appear to be patterns indicating that a conflict of values does exist. The rational construct of values systematically held in a societal context unravels within the context of war and returning combat veterans. Through interviews and participant observation, this preliminary study seeks to understand the experience of American service men and women who have returned from war. Two different veteran cohorts were sampled: veterans of the Vietnam War and those from the current Global War on Terror. Com-

parisons between these groups will add insight into the experience of cognitive dissonance associated with reintegration into civilian society and whether this is, and historically has been, a structural issue commonly experienced by veterans.

Introduction

In the play *The Trachiniae*, written by Sophocles, the heralded Greek soldier Heracles requests to be burned alive on a funeral pyre as he nears his death. Philoctetes is the only man willing to light the fire. In return for this favor, Heracles offers his bow to Philoctetes. Philoctetes accepts the bow and journeys towards combat in the Trojan War. Misfortune strikes when he is bitten on the foot by a snake. The bite leaves him in constant agony and emits a horrible smell and ultimately causes Odysseus to abandon him on the desert island Lemnos. Ten years pass, and the Greeks capture a Trojan seer who foretells that Philoctetes and his bow will be needed to win the war. Odysseus sails back to Lemnos to reunite with Philoctetes. Because he was abandoned on the island, Philoctetes bitterly hates Odysseus, which makes the task of convincing the wounded warrior to return to battle very difficult. Philoctetes feels he has been betrayed, that a social contract has been violated by those whom he served in battle.

The Greek play of Sophocles illustrates the social contract that is developed between soldiers and the civilian populations whom they serve by going to war. Like Philoctetes, U.S. soldiers agree to go to war in defense of their country with the belief that the civilian population they serve will care for them regardless of the condition in which they return: dismembered, traumatized, or dead. This unwritten social contract is important in understanding the relationship soldiers have with society upon their return from combat.

The story of Philoctetes is one of soldiers who have participated in war and upon returning home find reintegration back in to society difficult because the social contract is not upheld by their countrymen. Soldiers have faced these issues since the beginning of war. This raises the question of whether American soldiers face similar challenges of reintegration today.

Human beings create cognitive dissonance by holding two competing belief systems at the same time (Boring 1964). This descriptive study explores whether there is cognitive dissonance occurring among the general American civilian population with regards to a specific social contract. We coin the term the 'Yellow Ribbon Magnet Effect' to describe this social contract. In short, the two parties involved in the

contract are the American civilian population and members of the U.S. military. Military personnel perceive an agreement that says that if they will go to war and fight for their country, their country (i.e., American civilians) will take care of them regardless of the state in which they return. Specifically, a soldier understands that if he goes to war to defend his nation, society will take care of him regardless of whether he comes home in any way damaged, disfigured, or dead. The conflict in fulfilling the social contract between civilian and soldier takes the form of patriotic support (e.g., yellow ribbon bumper sticker) and actually following through with such things as support for veteran education and health benefits and general support for the reintegration of soldiers back into society. There is conflict between the competing values of patriotism in supporting the troops and the disdain associated with actually paying the high costs of providing necessary support to actually 'support the troops.' One specific example of the disdain component is exemplified by Bureau of Labor Statistics tabulations from the Current Population Survey showing that the unemployment rate of young veterans aged 20–24 years increased from 11.0% in 2003 to 15.6% in 2005 (Savych et al. 2008). This increase in unemployment among veteran youth is particularly worrisome to policymakers considering the fact that the overall youth unemployment rate declined during that time period. Researchers such as Kleykamp (2009) have found that military service may not be a great path to job security and economic success, despite commonly held beliefs to the contrary. This point is supported by the high unemployment rates currently experienced by veterans. It is possible that veterans experience negative bias when applying for jobs and other opportunities. Kleykamp also suggests this may be due in part to negative stereotypes regarding veteran's mental stability, political ideology, interpersonal skills, and other issues related to employment, which is what happened in large part with Vietnam veterans. Other researchers point out that the wars in Iraq and Afghanistan are often celebrated in media and public events while federal programs and policies lack necessary attention paid to veterans (Modder 2012). This is the case even when issues such as high veteran unemployment have a negative effect on the whole of American society.

This study begins by reflecting on the experiences of veterans of the Vietnam War who experienced great difficulty in reintegrating back into society after the war ended. In large part, this is due to the unpopular nature of the Vietnam War. There has been a reaction by the American public as well as government officials to ensure that members of the military are 'supported.' This is demonstrated by the widespread 'Support our Troops' campaigns as well as in official statements such as the following commentary offered by President Barack Obama directed

at veterans of the Vietnam War: "You were often blamed for a war you didn't start, when you should have been commended for serving your country with valor. You were sometimes blamed for misdeeds of a few, when the honorable service of the many should have been praised. You came home and sometimes were denigrated, when you should have been celebrated." (Obama, May 27, 2012).

Reactions to how Vietnam vets were perceived to be treated by the American public, and as an extension, government, cemented the social contract that American veterans will be taken care of when they come home from war in return for their service to their country. Veterans are in a unique position to see the dissonance of competing values between patriotism and actually having to meet the demands of the social contract occurring in citizens because they are the recipients of that agreement. Vietnam veterans who participated in this study are vital in establishing this narrative as modern values associated with the social contract stem in large part from their experiences. The Global War on Terror (GWoT) interviewees give further credence in establishing whether they perceive that American civilians are indeed experiencing a conflict of values expressed through social and policy reactions affecting veterans.

Background

Alan Whitmarsh (2007) described an experience similar to that of Philoctetes in his post-WWI research on veteran social integration. He argued that many "shell-shocked" men did not receive adequate care because of government parsimony and pre-war social values coming into conflict with returning veterans. Thus, veterans struggled with pension authorities and medical officials long after the war ended. Every war that the United States has fought has created challenges for veterans reintegrating into society. Specifically, the perception that society does not hold up its end of the social contract is pervasive among veterans. This study will focus on two American cohorts: veterans of the GWoT and veterans of the Vietnam War. There are marked differences between these cohorts. For example, the Vietnam War pulled a higher percentage of the American population into combat. The GWoT, on the other hand, is fought by a much smaller proportion of the population. Compounding the issue is the fact that those who do participate in the war experience higher rates of multiple combat exposure. With regard to GWoT veterans, Karin Jordan (2011) explains that veterans of the longest war the U.S. has ever fought are experiencing increased stress because the actual number of participants is significantly smaller and deploys more often than past cohorts. Active-duty personnel commonly

experience repeated deployments, often receiving redeployment orders before they return home, as well as extended deployments of 12–18 months at a time. These combat veteran cohorts provide a contrast in the experience of returning home. Hill Glover (1984) argues that the social contract obligations of society were scantly applied to the Vietnam veteran cohort. In his study, he explains that the attitude of the public towards the returning veteran ranged from indifference and lack of recognition to hostile condemnation. It is therefore not surprising that Vietnam veterans would feel mistrusting and alienated, according to Glover. Many Vietnam veterans were drafted, which also provides an important distinction between the Vietnam War and the GWoT, which is fought by an all-volunteer force.

There have been many studies exploring the reintegration of combat veterans into society, yet few focus on whether returning veterans create a conflict of values within the civilian population. One such study by the Pew Research Center (2011) dealt specifically with reintegration. This study found that reintegration has been more difficult for veterans of the GWoT than it has been for cohorts of wars past. The study found that 44% of GWoT veterans had difficulty readjusting back into society compared with about a quarter of veterans in the past. This may be explained by the fact that GWoT veterans are much more likely to have seen combat and also to have experienced multiple deployments. This study is a strong indicator that the reintegration of GWoT veterans has been and will be even more difficult than prior veteran cohorts. It also creates a baseline to compare the responses of the veterans in this study to other established research on the topic. Although not looking specifically at conflicting values in society, research has been done examining war injuries in general.

Achter (2010) notes the importance of physical appearance in American society and explains that bodies that have been physically deformed as a result of war wounds are seen as 'wrong' and outside of the norm. Achter acknowledges that injured servicemen threaten social connections, similar to the story of Philoctetes; however, there are few studies that explore why the connections are strained. This thread of injured military veterans creating cognitive dissonance among civilian populations appears to be not only a current issue, but one that runs through history as far back as the Ancient Greeks, and likely beyond.

We contend that the "Yellow Ribbon Magnet Effect' relieves the dissonance created by the opposing values of 'we support the troops' patriotism and the reluctance to allocate personal resources that are required to actually support veterans. For example, by displaying a yellow magnet on a person's car, the individual is able to wash their hands of any feelings of guilt that care for veterans is inadequate. If they are

'supporting the troops' by their yellow magnet display, certainly they cannot be blamed for not 'supporting the troops.' The act, therefore, of actively participating in an action that is perceived to 'support the troops' becomes relief for the dissonance felt when the reality of veteran's issues becomes publicly known.

We believe that this topic is increasingly important to understand as we are currently experiencing an influx of 2.5 million combat veterans reintegrating back in to society. We seek to understand the challenges they face in order for their service to be honored and the social contract to be upheld.

Hypothesis

This descriptive investigation seeks to take preliminary steps towards understanding whether returning combat veterans create a conflict of values within their receiving society. We hypothesize that veterans will experience a conflict of values in the form of experiencing a broken social contract. Specifically, we hypothesize that veterans will believe that society has entered into a social contract with them that says that in return for their service, veterans will be accepted back into society and taken care of in whatever state they return. We suspect that veterans will perceive that this contract has been broken in that the American public generates a message that says 'we support our troops' while not actually fulfilling that responsibility.

Methods

This study uses qualitative interviews to understand the veteran perspective and experience of returning home from war. Two cohorts of U.S. veterans of war are compared. The subjects of the study are combat veterans of the current GWoT and the Vietnam War. The veterans have not only been in theater, but all have seen direct combat. The primary author of this article first contacted a GWoT active-duty service member who is currently a 1st Sgt. of the 3 Ranger Battalion. This individual then put out a call to his company of 110 men and other military contacts that a study was being conducted and responses followed. Task Force Dagger, a foundation that provides assistance to injured, wounded, or ill U.S. special operations soldiers and their families, also provided assistance in locating potential participants for this study. The author also contacted a Vietnam War veteran who was a member of the special forces community during that conflict. This individual then contacted his fellow veterans and interviews snowballed from his extensive contact list. The interviews lasted no more than one hour and focused specifically on reintegration back into mainstream

society and the perceived reactions to that reintegration. The interviewees were free to comment on their personal experiences, perspectives, and feelings on reintegration. The questions were designed to understand whether soldiers returning home from war perceive a conflict of values in civilians.

A majority of the interviewees served in high-tempo combat units like Special Forces (Green Berets) and Rangers, which are exposed to a greater amount of combat than other units; however, all of the participants have seen direct combat during their careers. Four branches of the military—U.S. Marine Corps, U.S. Army, U.S. Navy, and U.S. Air Force—were represented to increase generalizability. Combat veterans ranged in rank from Sergeant (E-5) to Sergeant Major (E-9) indicating maturity and cognitive reasoning abilities represented by rank. Three of the interviewees are Vietnam veterans who enlisted in the Army, and all of the remaining 22 interviewees are GWoT veterans.

The primary author of this article is a multi-war combat veteran. He conducted the interviews to ensure that ample space and safety was afforded to responders. Given that the subject matter has the potential to stir strong emotions, the researcher is uniquely qualified to ask the subjects questions being a combat veteran himself. Combat veterans typically trust and will more openly express their thoughts with a fellow combat veteran as opposed to someone with no combat experience. The interviews occurred at locations chosen by the interviewees to provide as much comfort and safety as possible. The actual names of the interviewees are kept confidential to protect the privacy of the subjects. Contact information for the Veteran's Administration and social workers with expertise in combat veteran issues was made available to all interviewees.

Data have been collected through one-on-one interviews, which were recorded by a live scribe pen to create precise transcriptions with correlating notes. Data have been organized using reduction and interpretation methods. Specifically, responses have been color-coded to allow for comparisons and pattern identification with key indicators being dissonance and reintegration.

All of the participants were screened to ensure that they were combat veterans who had seen direct action. Because the primary author is a combat veteran, it was not difficult to communicate with fellow soldiers who satisfied the criteria to be included in this study.

Results

Several consistent patterns emerged among the interview responses. Soldiers consistently raised the question, "How can they (ci-

vilians) get or help me if they weren't there?" The soldiers clearly feel that the American civilian public remains ignorant to the needs and experiences of soldiers. The social contract implies that in return for their service, soldiers should be taken care of upon returning home from war. The conflict in values occurs when soldiers feel that the civilian society is supportive of war efforts but does not follow through with accepting the responsibility to deal with the consequences of war. There seems to be a chasm between civilians and combat veteran because one group cannot understand the experiences of the other and the other knows they cannot be understood while still recognizing that they need help from those who can't understand them. Further, the combat veterans feel that their experiences create a sense of uneasiness from those around them who have not shared in similar experiences.

When asked to respond to the statement that Americans do not understand what combat veterans have been through, Vet G provided a representative response by answering, "ABSOLUTLY, most Americans think a bad day is one stuck in traffic, no cell reception, a broken X-Box, and breaking up with their significant other. A bad day for us is watching your best friend getting blown in half, not sleeping for a week while somebody is trying to kill you, not knowing if you will ever see your loved ones again, wearing a 110 lbs. of shit, and running around in it in 110 degree heat for 12 hours. Nobody will ever know it unless they have lived it." Vet G is a member of the Green Berets and has served in both Iraq and Afghanistan during 6 deployments.

When responding to the story of Philoctetes, the revered combat veteran who was shunned for his injuries, Vet D made the following statement that exemplifies this experience, "Yes, for the most part, we had a saying about it when we first got home, not sure where it came from, it was, 'if you can't walk beside me, don't stand behind me.' I honestly don't feel like I earned empathy, more like I wish people were more apathetic than anything." Apathy is a typical symptom of someone trying to deal with two conflicting values. It is a way to relieve pressure that conflict causes. Vet D indicated that apathy is prevalent in members of society with whom he interacts. Vet D was a combat medic injured while helping other injured soldiers after a roadside bomb attack. His remarks about the Philoctetes plight are compelling because he literally tended the wounds of fellow soldiers.

It is clear that the veterans felt that they are in a no-win situation and as a result interact for the most part with other veterans. Vet F stated, "It has gotten to the point that the only people I really hang out with are people I deployed with or that have deployed before, but even then the experiences are so different there really isn't anyone to talk to or interact with without things getting weird." This withdrawal supports

previous studies about soldiers having difficulties reintegrating (see Pew Research Staff 2011).

A World War I story titled 'All Quite on the Western Front' did a great job of exploring the conflict of values that soldiers may cause when coming home from war while expecting the civilian population to uphold their end of the social contract. The story is told from the perspective of a young German soldier named Paul Bäumer. It is powerful in part because Germany was the enemy of the United States, and yet both sides appear to experience the same troubling consequences of war. Paul's visit on leave to his home highlights the cost of the war on his psyche. The town had not changed since he went off to war; however, he feels that he does not belong there anymore, that it is a foreign world. He feels disconnected from most of the townspeople. His father asks him 'stupid and distressing' questions about his war experiences, not understanding 'that a man cannot talk of such things.' While his father revels in his son's war experiences, his mother is horrified that he has taken life. The mother experiences a conflict of values in that she loves her son while at the same time finds it difficult to love someone who has taken life. The conflict of values in celebrating the taking of human life, when most of society would normally never do so, is laid out in the book. Paul could only find solace with other soldiers, similar to Vet F's experiences. The protagonist Paul sums it up this way, "I breathe deeply and say over to myself: 'You are at home; you are at home.' But a sense of strangeness will not leave me; I can find nothing of myself in all these things. There is my mother, there is my sister, there is my case of butterflies, and there is the mahogany piano – but I am not myself there. There is a distance, a veil between us." (Remarque 1929, pg. 160)

Limitations

There are several limitations of this current study due in large part to the preliminary nature of the investigation. The intention of this study was to conduct preliminary research to help inform future research and to determine if there is, in fact, validity to the claim that a break in the social contract between soldiers and civilians exists. The sample size is limited, and while efforts have been taken to increase generalizability, it will be necessary for future research to continue to explore this issue in greater detail among extensive cohorts and veterans with diverse experiences. There may also be issues of bias as the primary investigator is himself a veteran. The study has been formulated based on the experiences of the author, which may lead to self-selection or other forms of bias in spite of the fact that efforts were

taken to protect against these effects. Regardless, this article raises several important questions that deserve further investigation. The United States is currently engaged in prolonged armed conflict, and the impact of this reality is not only an important topic for the expansion of social science, but ultimately important to the well-being of society as a whole.

Discussion and Suggestions for Future Research

Because of the exploratory nature of this descriptive study, several issues were raised after the interview process and data analysis had been completed. The following issues are worthy of further exploration. A common perception held by respondents was that society dismisses the negative experiences of veterans because current wars are fought by an all-volunteer force. In past conflicts, conscription forces meant that soldiers could not or should not be held solely responsible for the experiences that they had endured. The belief then follows that the current cohort of soldiers has no excuse. They volunteered for their experiences and therefore should not complain. Vet R explicitly expressed this sentiment when explaining, "civilians say you volunteered, what are you bitching about? If you didn't want to see war, why did you enlist? Who in the fuck are they to tell me I volunteered and to not bitch about it?"

This new pattern revealed in the data is worth further exploration. This is the first time in U.S. history that a prolonged war has been fought with all volunteers. Do American civilians view the plight of the solder as one that is deserved because 'they signed up for it'? If not deserved, is the plight of the soldier at least dismissible as a social issue that does not merit attention? This could be one possible factor in the aftermath of war that may inhibit combat veteran reintegration back into society. Further exploration of issues surrounding Stop Loss or the "back door draft" and how combat veterans forced to serve longer than their volunteered contract time feel about this issue would also be relevant and important to understand.

It would also be worth exploring the differences or similarities experienced by both combat and non-combat veterans. Future research should explore not only the experience of these two groups but also how these two groups perceive each other. This would help to control for the experience of combat and to explain what role combat has in shaping the perception of soldiers. Similarly, cohorts from different conflict periods should be compared.

In conclusion, the hypothesis that returning combat veterans create a conflict of values within the society to which they are returning has been supported by the evidence gathered by this study. The re-

sponses given by combat veterans indicate that such a conflict in fulfilling the social contract may indeed exist. The social contract falls within the theory of the norm of reciprocity, and further exploration of this theory in relation to soldiers returning home from war would be prudent. Veterans have observed many instances of civilians trying to minimize the conflict of values, which again supports the hypothesis.

As expressed in this article, there is evidence to suggest that cognitive dissonance associated with veterans returning from war is a recurring pattern. This has been experienced and documented as far back as Ancient Greece and has repeated itself in contemporary history. The pattern appears to be continuing today. We have an opportunity to learn from the mistakes of the past and doing so would benefit not only those men and women who serve their nation, but the whole of society.

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Abstracts

ARTS

The Hero Cult: The Creators of Presidential Pop Art Propaganda

Courtney R. Davis
Utah Valley University

The author seeks to understand the duality and dichotomy of politically motivated pop art and those who produce it. Concentrating on presidential campaign posters, this paper will address pop imagery as a mediator between the artistic creator and the mass consumer. Shepard Fairey's Obama Hope poster (2008) and a recent Occupy Wall Street poster (2011) will provide a framework for considering the cult of the pop hero: While the former poster garnered near-universal praise, the latter has met with a markedly chilled public reception. Tarnished by a highly publicized copyright infringement lawsuit, Fairey seems to have reclaimed his roots as an activist, street-artist outsider, rather than a mainstream pop artist hero. To account for this shift in acceptance, this paper will consider the subtle variables of pop art propaganda including the power of celebrity, public approval, artistic status, and American consumerism.

ARTS

Useful Lies

Brent Hanson
Dixie State College

This paper examines the creative and formative activities involved in writing a musical theatre piece based on historical characters and events. The goal of the paper is to explore that squishy territory between artistic expression and historical fact. The recent writing and performance of Nathan Hale at Dixie State College is used as the case

study in the exploration. The paper is anchored in the impact that authorial intention has on the play between documentary fact and creativity. It considers the role of research in writing and performance activities. It analyzes how the practical realities of a highly collaborative working process can affect choices in regard to historical truth and artistic interpretation.

ARTS

A Human Right to Wealth

Inez Harwood
Utah Valley University

Proving discrimination based on financial standing should be easy, since the poor receive drastically different banking and investment options than the rich. Some would argue that risk management is just good business, but is it constitutional? The Occupy Wall Street movement by touting slogans that protest financial inequality claims that it is a latent response to the civil rights movement of the 1960s. The civil rights movement based its legitimacy on the writings of Gandhi, who asked society to self-examine whether its political leadership effectively represents all of its members. The theme of civil disobedience without violence to bring about political change is a strategy rooted in the writings of Gandhi, whose methods are in practice by Occupiers today. The claimed hierarchy of legitimacy of Gandhi to Dr. Martin Luther King's civil rights movement is indisputable; however, adding the Occupy Wall Street movement to this thread has it's problems. While Gandhi used poverty to prove that the British government was not addressing the best interests of India, and Dr. King used poverty to prove that minority groups were under oppression, Occupiers claim poverty itself as a form of oppression. This claim brings several issues to debate including proving whether financial status informs the decisions of leadership; whether the requirements to ascend to American upper class favors a particular group; and whether the possession of wealth affords a right to political, social, and economic privilege. Many feel that fair and equal opportunity for wealth and security is a fundamental issue that the founding fathers wished to address when designing the United Sates Constitution; however, the concept that the rich should not control the destinies of the poor is difficult to put into practice and is a reoccurring theme of civil unrest through out world history.

ARTS

The Dynamics of Intense Work Groups in Professional Symphonies in Europe, the United States, and China

Douglas K. Peterson
Westminster College

This paper is an addition to the original Murnigham and Conlon (1993) paper on the dynamics of British chamber orchestras. In this case, the study documented the cohesion processes of chamber orchestras and projected that other chamber orchestras would follow similar patterns. With the help of a major symphony in the United States, the replication of Munigham's paper, and a grant from People's Republic of China, we intend to compare and contrast the contextual and cultural differences in leadership and cohesion. This is an empirical study and for this conference the explanation, hypotheses, and methods will be discussed. The Chinese government intends to allow for the data collection through a grant, but that data collection won't occur until Summer 2012. It is expected that the central findings of leadership versus democracy, the role of the second violinist, and confrontation versus compromise will vary significantly. Previous findings indicate that the more successful quartets recognized but did not openly discuss leadership and complex processes involved in the high-intensity work activity. Instead, they managed these inherent contradictions implicitly and did not try to resolve them. The discussion addresses the study of intense work groups, the forces that drive the paradox, and potential applications to other organizational groups on a cross cultural basis.

ARTS

Ballroom Dance: Appropriation or Art Form?

Shellie Davies
Utah Valley University

BIOLOGICAL SCIENCES

Casein kinase 1 δ in migraine with aura

Aaron Sahim, Chase Swapp, Sarah Bahr and Emily Bates
Brigham Young University

Migraine is a debilitating illness affecting over 30 million people in the United States. Correlations to the menstrual cycle and increased pain sensitivity in response to estrogen suggest that differences in estrogen signaling may contribute to migraine. It has been shown in recent research that the T44A mutant in casein kinase 1 δ (CK1δ) contributes to the mechanism of migraine. CK1δ phosphorylates estrogen receptors, putatively regulating their function. Our research focuses on two estrogen receptors (ERα and ERβ) believed to be downstream of CK1δ. We are determining whether differences in the expression of ERα and ERβ cause increased pain sensitivity in mice models. To do this, we inject ERα and ERβ knockout mice and with a migraine trigger called nitroglycerin. We then determine their threshold for detecting thermal stimulus in a blind experiment. Understanding the effect estrogen has on migraines will help guide us to new and more effective treatment methods.

BIOLOGICAL SCIENCES

Occurrence of Bacteria on Fomites in a University Athletic Setting

Jason J. Bass, Blake A. Sellers, Tana Eggleston, Craig Oberg, Karen Nakaoka, and Joel Bass
Weber State University

With the spread of *Staphylococcus* respiratory and enteric infections among student-athletes increasing, indirect contact via environmental surfaces becomes a significant concern, particularly for Methicillin-resistant *Staphylococcus aureus* (MRSA). A variety of surfaces that student-athletes come in contact with on a day-to-day basis were tested for total bacterial load, *Staphylococcus*, and coliforms. Surfaces included taping and treatment tables, muscle stimulation pads, ultrasound heads, weight lifting equipment, tape cutters, keypads, ice machines, and helmets. VJ agar was used to isolate staphylococci, EMB agar for coliforms, and TSA agar for total bacterial counts. A 5 x 5 cm^2 area

was swabbed, diluted, and plated on each medium, with solid surfaces also sampled using Rodac plates. Coliform counts increased on taping and treatment tables during use each day until evening cleaning. Footballs, door keypads, tape cutters, weight plates, and helmets had the highest recovery of organisms including coliforms. *Staphylococcus* was recovered from tape cutters, helmets, keypads, and footballs. Items generally overlooked for regular cleaning had higher microbial loads including potential pathogens. Results suggest that target cleaning of fomites routinely handled by student-athletes could reduce possible transmission of pathogens and that microbial screening of high-use fomites and locations be performed to establish more effective cleaning procedures.

BIOLOGICAL SCIENCES

Baseline Bacteriological Study of a Pristine Cave in Grand Canyon–Parashant National Monument

Amber Franklin, Andrew White, and Donald Warner
   Dixie State College of Utah

The discovery of a pristine cave in 2008 within Grand Canyon-Parashant National Monument presented an opportunity for conducting scientific research in an undisturbed cave. PARA3405 is a unique wet cave found within the Redwall Limestone Formation (Mr) in an area of uranium ore bodies. The approximately 170,000-square-foot multi-chamber cavern is highly decorated with cave formations and pools of water that have been formed by seepage from an overlying open aquifer adjacent to a detachment fault. This survey was done to provide baseline information for future studies of microscopic life forms within the cave. Water samples were collected from pools within one chamber of PARA3405, and bacteria from these samples were then cultured on a nutrient agar. Baseline information tested included bacterial counts, pH tolerance, and ultraviolet (UV) light resistance. Upon initial examination, neither living bacterial counts nor total counts could be performed because of unexpectedly low concentrations of bacteria within the water samples. Based on conditions in PARA3405, the effects of two environmental variables were examined for the few living bacterial specimens found. Bacteria were isolated and successfully cultured on pH 10 and pH 11 media, suggesting that some of the specimens sampled are alkaliphiles. Isolated bacterial species grown on standard media were exposed to UV light for different lengths of time resulting in

some isolates that were resistant to prolonged UV exposure, suggesting these bacteria may be resistant to shorter wavelengths.

BIOLOGICAL SCIENCES

Dpp requires Irk2 to pattern the *Drosophila* wing

Giri Dahal, Joel Rawson, Ben Kwok, Brandon Gassaway, Elise Wilson, Alex Johnson, Devon Kinghorn, and Emily Bates
Brigham Young University

Andersen-Tawil Syndrome (ATS) causes craniofacial abnormalities and limb defects. Most ATS patients have mutations in the Kir2.1 inwardly rectifying K+ channel. Deletion of mouse Kir2.1 causes palate and limb defects that are similar to defects that occur because of reduced bone morphogenetic protein (BMP) signaling. We tested the hypothesis that Kir channels are important for BMP signaling in *Drosophila*. Irk2 is a *Drosophila* homolog to Kir2.1. irk2-deficient lines, irk2 RNAi, and expression of a dominant negative Irk2 subunit demonstrate that compromised Irk2 function causes wing-patterning defects similar to those found when *Drosophila* BMP, Dpp signaling is disrupted. Irk2 dominant negative phenotypes are enhanced by reduced Dpp signal. Reducing function of Irk2 with siRNA, deletion, or expression of dominant negative Irk2 reduces Dpp signaling. Since BMP is responsible for inducing metastasis and immune evasion of many types of cancer, inhibiting BMP signaling by blocking Kir channels specifically in tumors could decrease cancer progression.

BIOLOGICAL SCIENCES

Characterization of *Marinobacter* Phage TS22 Isolated from the Great Salt Lake, Utah

Thomas B. Simon, Craig J. Oberg, Michele D. Culumber and Mathew J. Domek
Weber State University

A halophilic phage that infects *Marinobacter* SA51, TS22, was isolated from the Great Salt Lake. A one-step growth curve showed a replication time of 40 minutes, an eclipse period of 10 minutes, and a burst size of 65. The effects of NaCl, MgSO4, and KCl salt concentrations on

TS22 attachment and infection were tested. The phage was incubated with SA51 in a solution of 0%, 6%, or 12% of each salt for 10 minutes. Cells were then diluted and plaque-forming units/ml were calculated. Attachment was greatest at 6% NaCl. When NaCl was replaced with either MgSO4 or KCl (6% w/v) during attachment, a 10-fold and 100-fold decrease in plaque number was observed, respectively. In the absence of salt, plaque formation decreased 1000-fold. It appears that salt type and concentration influences phage infection in *Marinobacter*, perhaps because of changes in charge density of the surfaces or receptor sites, which alters attachment. This finding suggests how seasonal and climatic events could alter phage–host interactions, thus impacting recycling of microbial biomass in the lake.

BUSINESS

People, Relationships, and the Institution

Andrea Ibanez
  Utah Valley University

Not only is Utah Valley University (UVU) the largest public university in Utah, but also the largest employer in the city of Orem (UVU employs over 1,400 full-time faculty and staff and over 3,200 part-time faculty and staff). Alternative Dispute Resolution (ADR) programs should be situated in organizations aspiring to be efficient in all aspects and programs of this nature are vital in organizations of this size. For example, research shows that success in both formal and informal mediation is correlated to the success of such organizations. The following are three major objectives that will be outlined and addressed in this research:

1. Assess the current method of resolving disputes at UVU.

2. Accumulate research to create an effective ADR Mediation program tailored to UVU.

3. Propose said program with full anticipation to place in effect.

To evaluate the current ADR program, data have been collected from various sources within UVU. Additionally, information will be collected through studies of parent–teen interactions in formal mediation

sessions. The research will analyze the components of parent–teen relationships and compare them with those of an employer–employee relationship. The most valuable information will contrast the difference between superior–subordinate relationships and interpersonal relationships. It is believed that UVU can perform more efficiently if the ADR mediation program is updated and revitalized, also resulting in financial improvements and increased employee morale.

BUSINESS

The Advantages of Using Fiction in the Teaching of Technical Material in the Business Classroom

Richard E. McDermott
Weber State University

Multiple authors have explored the use of fiction in teaching such diverse topics as physics, sociology, family dynamics, law and so. For ten years, McDermott has published two versions of a textbook/novel (*Code Blue*). One of these is directed at the business school market and teaches healthcare administration and hospital cost accounting. The other directed at the Nursing School market and teaches principles of managed care. The author will review the advantages of using fiction in the teaching of technical material and will review principles for one interested in developing similar teaching materials.

BUSINESS

An Unpopular Proposal Is Now Popular: A Case for a National Sales Tax

Richard Parson and Ronald M. Mano
Westminster College

In 1986, one of the coauthors published an article, "An Unpopular Tax Proposal," in *Management Accounting*, the official journal of the National Association of Accountants. The organization has been renamed the Institute of Management Accountants, and their official journal is now called *Strategic Finance*. In that article 25 years ago, the authors recommended replacing the income tax with a sales tax. It seems that

just like bow ties and skinny pants, this "unpopular" idea has now found a large and growing fan base, with many supporters for what is now often called, "The Fair Tax." Many of our comments now are similar to those made 25 years ago, with some new insights added.

BUSINESS

Personality and Competitive Antecedents of Sales Performance: Surprising Findings

Adam Webb, Paul Dishman, Spencer Petty, Jarrod Heiner, and Jorge Marimontes
Utah Valley University

In this study, individual personality and competitiveness traits were assessed as predictors of personal sales performance. Need for Achievement, Need for Power, Need for Affiliation, Interpersonal Competitiveness, and Goal Competitiveness were measured in sales representatives from three different companies within the multi-level marketing industry. Participants were broken into high and low performance groups, and scores were correlated to each group. Results indicated that: (a) Interpersonal Competitiveness strongly predicts sales performance within multi-level marketing; and (b) other constructs yielded surprising correlations. Limitations to the study include sample size and uneven gender sampling. The research accomplishes three objectives: irst, to study predictive performance traits in a previously untested industry—multi-level marketing; second, to establish whether traits predict performance differently depending on industry; and third, to create a simple and effective questionnaire to assist hiring managers in predicting the performance of potential new hires.

BUSINESS

Russia's Sovereign Debt Crisis, 1800-1914

Dwight Israelsen
Utah State University

With sovereign debt crises in Europe threatening economic recovery in that region as well as in the U.S., it is of interest to compare the current European crisis with that of Russia in the nineteenth and early twentieth

centuries. We utilize information on the characteristics of every sovereign debt issue of the Tsarist government of Russia from 1800 to 1914, as well as economic and demographic data, fiscal and monetary policies, and policy statements of Russian Ministers of Finance, to identify the causes of the debt crisis that emerged in Russia in the nineteenth century. In comparing Tsarist Russia's sovereign debt crisis with contemporary debt crises in European countries (and in the U.S.), we find both similarities and differences. While all of the major causes of Russia's debt problem are represented in contemporary sovereign debt crises, the glaring differences in causes of the current crises include extensive borrowing to finance expanding social entitlement programs (which were virtually absent in Tsarist Russia), economic stimulus programs, and financial company bailouts

BUSINESS

Socio-Demographic and Financial Predictors of Discharged Chapter 12 Bankruptcies for Utah, Idaho, and Wyoming

Lucy Delgadillo and Jessica Johnson
Utah State University

This study examined the socio-demographic and financial characteristics that were associated with the likelihood of a discharge among Chapter 12 bankruptcy filers in Utah, Idaho, and Wyoming. This study contains individual filer-level data from 158 Chapter 12 bankruptcy cases filed in Utah, Idaho, and Wyoming that were filed between 1997 and 2005. The principal finding in this study is that filers with longer repayment plans and those that live in the state of Wyoming and Idaho are more likely to attain a discharge. However, debtors in Utah are more likely to reach a discharge in a shorter time than those living in Idaho or Wyoming. The Bankruptcy Abuse and Consumer Protection Act (BAPCPA), passed in 2005, made Chapter 12 a permanent chapter in the bankruptcy code. This study served as a baseline study before BAPCPA.

BUSINESS

Service and the Millennial Generation: The Effects of Volunteer Civic Service in the Lives of the Millennial Generation

Christine Diamond
  Utah Valley University

Service—it is defined in many different ways. From providing a service or good in a business to volunteering of your services to benefit others, service is an integral part of society. The various definitions of service will be discussed throughout this research, such as direct service, indirect service, and fundraising, then an exploration of the history of how volunteer civic service was standardized nationally in education, business, and churches will be discussed. The previous topics will be tied together with an understanding of the millennial generation and finally the effect community service has on the millennial generation. The research will be pulled from scholarly articles, local service organizations, and personal interviews with volunteers. This is meant to be an overview of the evolution of service from the middle ages to the modern day.

BUSINESS

Teaching Business Disciplines More Realistically: Chaos, Significance, Mechanisms, and Managerial Applications

Douglas K. Peterson
  Westminster College

Imagine a business model including and extending beyond Cohen, March, and Olson's garbage can (1972), and Nash's game theory (1952) while approaching Baumol and Ben-Habib's (1989) chaotic paradigm. What we get are models for studying and teaching administrative disciplines that are far more dynamic and inclusive of the multiple interests of multiple players. As educators, we have the opportunity to teach with a far greater complexity that extends beyond mid-level theory into a multipartite movable model accounting for multiple player's moves at the environmental, organizational and individual

levels, all using very simple concepts, differential equations, and games. This work is a significant, creative and original extension of the differential and fractal equations existent in the literature from the 1980s to the present.

BUSINESS

Personal Relevance: The Involvement Attitude as a Characteristic of Entrepreneurs

Peter B. Robinson and Marlow A. Christensen
   Utah Valley University

Personal involvement refers to the extent to which an individual cares about an object (person, place, event, or concept) and perceives it to be important. A person may be involved to the extent that a specific object has personal relevance to them and has an influence on their behavior.   Involvement in an object influences social judgment, social cognition, and behavior toward that object. This study tested the effectiveness of the involvement attitude, as measured by the 20-item Personal Involvement Inventory, in discriminating between individuals who have started and managed a business and individuals who have not. A discriminant analysis was performed on data from 132 subjects. Results show that involvement is an effective discriminator between entrepreneurs and the non-entrepreneurs. Several implications for educators and perspective entrepreneurs are discussed.

BUSINESS

Paperless Processes: Survey of CPA Firms in a Smaller Market

Jeff Davis, Joe Hadley, and Hal Davis
   Weber State University

Many professional certified public accounting (CPA) firms are taking advantage of technology and software to implement paperless office processes in their client services and firm operations. With current technology, a paperless office is not just for large firms, in large markets. The survey was sent to partners of firms in a smaller business

market. The survey results regarding obstacles, challenges, and benefits of "going paperless" found that partners of firms who had implemented paperless processes generally indicated a higher level of challenges than the partners of firms who had not yet implemented paperless processes. This suggests that implementation of paperless office practices was more difficult than anticipated before implementation. However, the partners of smaller firms that had implemented paperless processes agreed fairly strongly with the benefits of "going paperless." The results of the benefits questions in the survey showed that the partners seem to believe that the benefits of paperless processes generally are worth the obstacles and challenges.

EDUCATION

Technology, Teaching and Learning

Mary Sowder, Vessela Illieva, Mi Ok Kang and Sandy Jay
Utah Valley University

In response to calls from accrediting organizations for teacher education programs (e.g. National Council for Accreditation of Teacher Education; Teacher Education Accreditation Council) for greater use of appropriate use of technology in teacher preparation programs, this study sought to provide evidence of factors affecting pre-service teacher learning in courses incorporating the use of iPad technology. Several local school districts have been awarded grants to purchase and use iPads in their classrooms and are expecting that pre-service teachers enter their teaching careers with an understanding of how they may be used to enhance student learning. However, little empirical research has been conducted into if, and how, the use of iPads may be effective in facilitating teaching and learning in the classroom at either the K-12 or the university level. This mixed methods study was designed to measure the impact of the use of iPads on pre-service teachers' learning about teaching and on their developing instructional practice. How might the use of iPads enhance learning in education courses? How might students' use of iPads in their university classes encourage the use of this technology during students' field experiences? Data for this study was drawn from student work in similar lessons with or without iPad assistance, from surveys of students' perceptions of the use of technology in teaching, from instructors' classroom observations, reflections, and assessments, and university supervisors' observations of students' field experiences. Preliminary analysis of the data indicates

that the long-term effectiveness of the iPad as an instructional tool for pre-service teachers is almost entirely dependent on the quality and diversity of the instructional design of the lessons, and that the use of this technology alone does not appear to be enough to ensure learning and/or greater implementation of iPad technology during the students' field experiences.

EDUCATION

Transforming Student Learning by Making Lessons Memorable

Prent Klag
Southern Utah University

This session will provide professors and instructors with powerful, hands-on, teaching strategies that will vitalize and transform classroom instruction and make lessons memorable. Using a synthesis of current research on quality teaching and instructional practice, participants will be introduced to methods that will motivate students, help them re-member more, apply learning to real-world situations, and enhance overall student performance and achievement.

EDUCATION

Experiential Learning: The Essential Pedagogy in Twenty-First-Century Classrooms

Jim McCoy
Southern Utah University

Current educational reform movements at all levels of America's educational system are calling for the adoption and inclusion of Experiential Learning Theory (ELT) into the instructional practices of the organization. ELT provides a holistic model of the learning process. The primary focus of the theory is experience, which serves as the main driving force in learning, as knowledge is constructed through transformative reflection. Creating an experiential learning environment can be challenging for many educators who have been taught primarily through traditional classroom techniques. As contemporary educators

review the principles of three of the earliest educational theorists advocating for experiential educational practices, we can identify some of the most essential strategies that are needed for implementing ELT into today's classroom. Johann Pestalozzi, Maria Montessori, and John Dewey provide essential information for twenty-first-century educators who would successfully embrace and implement experiential learning theory.

EDUCATION

Plagiarism Correlation Due Dates

John Hill
  Salt Lake Community College

The author conducted a quantitative research study on plagiarism correlation to due dates in online college courses. It was determined that there was a significant correlation between the occurrence of plagiarism by students and the time of submission of assignments prior to due date at the online colleges studied. There are beneficial lessons for the college community that emerged from this study. These lessons are conducive to reducing plagiarism by deployment of strategies to curtail plagiarism.

EDUCATION

Taking a Closer Look at Learning Failures

Keith Proctor
  Brigham Young University

Learning failure research in the past has been dominated by findings about what its causes are and how to control it. This paper outlines the history of this body of research and makes recommendations for future areas of study based on a comprehensive literature review of college student learning failure. Past findings tend to suggest that all learning failure outcomes are negative and should be avoided. This perception is most acute in studies dealing with self-efficacy and learned helplessness. This perception also coincided with the "error-less learning" movement of the 1980s. Around this same time, however, researchers began publishing counter-evidence to these claims, insisting that learn-

ing failures could be constructive and motivating under certain conditions. The works of these researchers, as well as those who are currently exploring learning failure affordances today are discussed. A framework for understanding the developments in learning failure research is proposed.

EDUCATION

Analysis of Student Daily Test Scores in Multi-Day Test Periods

Jeff Davis and Matt Mouritsen
  Weber State University

The averages on beginning accounting students' test scores went down as students take the test later in the multi-day testing period. Further study analyzes test scores from tests taken in days one, two, three, and four controlling for such things as gpa, semester load, and total number of credits taken at college at the time of the test.

ENGINEERING

Multispectral Analysis of the Mangas Khipu Board

Madison Hanny and Gene A. Ware
  Utah State University

Multispectral Image (MSI) processes can greatly enhance readability of ancient documents. This study evaluates various MSI processes applied to a nineteenth-century Khipu board found in Mangas, Peru. A Khipu board is a wooden board with columns of holes in which are threaded encoded cords called khipus. Khipus use a variety of colors and knot forms to record information, although the meaning of the colors and knows remains unknown. A list of names is glued on both sides of the Mangas Khipu board. It is believed that the khipus in the Mangas Khipu board contain instructions and other encoded information that correspond to many of the listed names and that understanding this correlation may lead to the ability to decipher other khipus; however, some of the text is illegible because of dirt, bat urine, torn pages, or faded ink. It is of great interest to enhance the readability of the

Mangas Khipu board to more accurately evaluate the correlation between the khipus and the text.

ENGINEERING

Airglow-CubeSat with Orientation Control by Aerospike Puff-jets

Stewart M. Hansen, Braydon J. Williams, Jackson Andrasko, Doran Baker, Benjamin Blakeley, Jonathan Jensen, Jason Johnson, McKay Lund, Jacob Nieveen, Steven Swenson, Kyle Westwood, and Nephi Williams
Utah State University

Observations of upper atmospheric emissions further the understanding of the effects of the chemiluminescent energetics of the Earth's atmosphere. The Airglow-CubeSat will scan the desired altitudes of the mesosphere and the upper thermosphere, and the resulting data will verify results collected from measurements taken from rocket profiles as well as the SABER satellite. Atomic oxygen emits visible wavelengths; the Airglow-CubeSat will be monitoring the green line at a wavelength of 557 nm. Research is also being conducted into the feasibility of using aerospike technology for altitude maintenance and satellite orientation control.

ENGINEERING

Aerodynamic Electrical Energy: Wind Turbine Study

Andrew Nielson, Scott Marchant, Doran Baker, Michael Engh, Alvin Kang, Gustavo Estrada, Brandon Graham, Jason Johnson, and Jacob Nieveen
Utah State University

Renewable resources, such as wind, solar, and water, are important in energy production. This project will study wind turbine electricity generation technology and gain an understanding of the system design and engineering involved in producing electricity from the wind. Having observed the wind patterns on the campus of Utah State University, we

decided that we would obtain both a horizontal axis and a vertical axis wind turbine and mount them on the roof of the Engineering Lab building and measure the outputs of both turbines and compare the results to see which turbine type is better for low wind areas such as Logan, Utah.

ENGINEERING

Jet Flow Behavior Observed during Microgravity Boiling

Troy Munro and Heng Ban
Utah State University

A thin-wire, subcooled boiling experiment was performed onboard an aircraft flying a parabolic trajectory as a means to provide microgravity conditions. Microgravity allows for improved observation of jet flow phenomena and the ability to investigate their behavior in the absence of buoyant forces. A new mode of jet flows was observed in microgravity that accounts for the high heat fluxes measured on the wire heater. A relative bubble area analysis method was able to quantify vapor productions and bubble behavior across multiple frames of video. A cross-correlation calculation similar to particle image velocimetry (PIV) provided velocities of the micro-bubbles in the flow. These micro-bubble jet flows and the convection currents they induce have the potential to allow for sustained boiling to occur in microgravity at high fluxes.

ENGINEERING

SAM-Sun and Aureole Measurements

Kevin Jackson, Spencer Jackson, Gene Ware and Doran Baker
Utah State University

A ground-based optical instrument is being tested at Utah State University that can simultaneously measure the optical depth of clouds and the forward scattering of their associated particles. The bright region that appears to surround the observed solar disk is known as the aureole and is due to forward scattering of large particles. The system, engineering by Visidyne, Inc., is comprised of two imaging cameras, a solar track-

ing mount, data processing software, and particle scattering models. An auxiliary optical spectrometer operating in the visible and near-infrared wavelength regions provides coincident solar spectra. Column densities of atmospheric water vapor and ozone are derived from ratios of the spectral radiance, as well as the size distribution of aerosols.

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Canary Islands: Between Myth and Legend

Diego R. Batista
   Weber State University

In this paper, we attempt a first approach to the study of Canary Island identity (Canario identity), focusing on the original classical myths (Greek and Roman) that incorporated the islands to the common imaginary. We also look at the texts that followed, given that they acted directly or indirectly, to solidify a feeling of grandiosity, as well as of complete isolation, in the psyches of the present-day inhabitants of the islands. At the same time, we analyze certain aspects of the aboriginal society and its cultural permanence in the islands in an attempt to offer a panoramic view of the foundation for the formation of Canario identity throughout time and through word. Lastly, we examine how the Canario population has frequently turned to this topic to define not only themselves, but the socio-cultural relationships between the islands and the rest of the world.

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Aletheia and the Exuberance of Life

David F. Richter
   Utah State University

The intimate poetry of the contemporary Spanish writer Juan Antonio González-Iglesias frequently engages themes of pleasure and desire. His poetic orientation is certainly indebted to a variety of literary predecessors, but perhaps most of all to the ecstatic celebration of life evident in Jorge Guillén's "Cántico." González-Iglesias's 2002 collec-

tion, "Un ángulo me basta," elaborates the Guillenian interest in simple pleasures through a contemplation of a sensual material reality. By calling attention to elemental truths of art, love, and death, González-Iglesias's poetry evokes what the German philosopher Martin Heidegger calls aletheia to refer to the uncovering of the essence of being. In González-Iglesias's poems ''Alguien me habla de una biblioteca'' and "Tiene mi misma edad," this unconcealing of truth is evident as the lyrical subject digs deep below the superficial facades of architecture, nature, and relationships in search of their inner souls. This paper offers a close reading of poems from González-Iglesias's 2002 collection and focuses on the Guillenian spirit that infuses the contemporary poet's work as it urges readers to experience an exuberant renewal of how they experience the world.

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Bricks or Clicks? Asynchronous Matriculation in the Utah System of Higher Education

David Richard Keller
Utah Valley University

The Internet has produced alternate pedagogies for post-secondary education. I categorize, collectively, these alternate pedagogies as Digital Mediation. One pedagogy of Digital Mediation proposed for the Utah System of Higher Education (USHE) is Asynchronous Matriculation. On this system, students do not enroll for traditional semesters, but rather at unfixed points throughout the year for unfixed periods of time. The goal, in essence, is to replace bricks with clicks.

In this paper, I critically assess Asynchronous Matriculation. To do so, I first identify the ideal of Liberal Education as central to the Western intellectual tradition. Second, I isolate the Socratic Method as the pedagogy of Liberal Education. Third, I review the political function of Liberal Education in democracy and demonstrate that Liberal Education is a public good. Fourth, I critique Digital Mediation in terms of the Socratic Method. Upon close scrutiny it is evident that institutions of higher education fail to meet their duty to the polity insofar as they fail to provide the necessary ontological conditions for meaningful learning, and Digital Mediation fails to provide these conditions. Asynchronous Matriculation is therefore pedagogically unsound. Fifth and

finally, I draw a concrete conclusions for Utah state public policy. In the USHE, bricks cannot be replaced with clicks. Students must enroll in cohorts and attend courses on physical campuses to receive an education worthy of the politically engaged citizen. On-campus Liberal Education courses ought never be substituted with Hybrid, Canvas Infrastructure, or Asynchronous Matriculation programs. The Utah State Legislature must fund bricks-and-mortar buildings so that the USHE can fulfill its indispensable role in Utah democracy.

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Performativity in Seventeenth-Century Dutch Genre Painting

Scotti Hill
University of Utah

My research demonstrates how contemporary theory allows for the reinterpretation of previous historical periods. The modern notion of 'performance' applies to visual representations of Dutch identity in the seventeenth century.

Freed from the religious dictation of greater Europe, Dutch artists of the seventeenth century enjoyed a relative freedom of subject. Thus, Dutch art became a mirror to everyday life. Modern-day performance studies extend the scholarly approach of genre scenes by suggesting how real-seeming subjects may have tested viewers' knowledge of and response to patterns of conduct. Contemporary performance theorists investigate the agents influencing behavior and the modification of one's self to suit societal expectation.

Contemporary theory provides a rich context for broadening our understanding of art as a visual text, and a language of universal communication. This case study embodies the role of art historical research, which draws such connections from seemingly diverse historical and cultural circumstances.

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Violence, Passion, and Other National Clichés: Harold Trompetero's *El paseo*

Matías Martínez Abeijón
Southern Utah University

My current research focuses on the representation of some of the diverse clichés associated with Colombian national identity in Harold Trompetero's *El paseo* (2010). I explore the manner in which the film portrays both positive stereotypes of Colombia (i.e., the city of Cartagena as a tourist mecca) and those that are more challenging (that is, the ubiquitous presence of violence and crime). I deal with Trompetero's interest in creating movies that take advantage of iconic Colombian referents (e.g., the picturesque buses known as "chivas") while reinscribing motifs traditionally associated with such genres as the road movie and family melodrama. The presentation also explores the intersection of the arts, commerce, and national identity in the context of the notion of "nation branding." Thus, it investigates the links between the film and public relations campaigns that aim to improve Colombia's national image both domestically and abroad.

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Processing Instruction With and Without Meaning-Based Production: The Acquisition of Three Infinitival and Three Conjunctional Phrases

Rachel W. Kirk
Southern Utah University

This article examines the acquisition of the Spanish-language structures *para / antes de / sin + infinitive,* and *para que / antes de que / sin que + subjunctive* by intermediate and advanced intermediate students at the secondary level. Processing instruction (PI) alone and three combinations of PI and meaning-based production practice were used. The results of a pre-test, immediate post-test, delayed post-test design indicated a hierarchy of difficulty among the three structures with sub-

junctive and the three with infinitive. According to this study, the hierarchy of difficulty among the structures with infinitive appears to be *para < sin < antes de.* Of the constructions with subjunctive, the order of acquisition seems to be *para que < antes de que < sin que.*

LETTERS—FOREIGN LANGUAGE, HUMANITIES, PHILOSOPHY

Multiple Voices and the Psychology of Character in Maupassant's *Pierre et Jean*

Gary Godfrey
Weber State University

As Maupassant weaves his tale of two brothers in a nineteenth-century bourgeois family, his narrator gives up the omniscience of the earlier Realist novel. To replace it Maupassant must resort to stylistic devices that will make his characters credible while at the same time not appearing to exert deterministic control over their destinies. One such device, which becomes a tool of psychological analysis, is free indirect discourse. This study will examine the ways in which Maupassant develops the technique and specifically how it is used to underline the contrast in the two main characters in the novel, Pierre and his brother, Jean. Some other techniques will also be examined as they relate to the psychological development and analysis of the characters.

LETTERS—LITERATURE

Saint Joan and the Secular Stage

Jennifer Large Seagrave
University of Utah/University of Phoenix

My paper addresses George Bernard Shaw's modern adaptation of the medieval Saint Play genre in his 1923 work, Saint Joan. It argues that the conventions of the realist stage allowed Shaw to present the "truth" about the trial of Joan of Arc, humanizing her persecutors while simultaneously valorizing her faithfulness to her own convictions. In his presentation of Saint Joan, the secular dramatist co-opts a religious form to criticize the institution in which it arose and convey his own "religious" philosophy. Shaw's play exposes the Catholic Church's ad-

mission of "private judgment," making a concession for individual salvation outside its traditional doctrine, and in so doing "shames" the Protestant establishment for failing to honor such "freethinking." For Shaw, all progress must happen through evolution, for, as he puts it, "The law of change is the law of God."

LETTERS—LITERATURE

Ambivalence Towards Sexual Freedom and Loss of Faith in *A Farewell to Arms*

Emily J. Petersen
  Weber State University

Female characters in Ernest Hemingway's (1899–1961) work are often called "bitch goddesses." Despite the despicable, destructive, and even desperate actions of many of these women, their characterization as "bitch goddesses" may be one-dimensional, ignoring other facets of the Modernist movement (1914–1940), in which the "New Woman inspired a great deal of ambivalent modernist characterization . . . . [and] ambivalence toward powerful femininity" (Dekoven 174).

Such ambivalence is depicted in Hemingway's characterization in *A Farewell to Arms* (1929) of Catherine Barkley, a woman who has found sexual freedom yet ultimately pays with her life for it. She seems to represent the sexual freedom and loss of faith of the Modernist era; however, she dies because of her so-called sins, making Hemingway's iconoclasm and representation of women's sexual freedom ambivalent.

LETTERS—LITERATURE

A Suppressed Explosion: The Spanish Civil War in Malcolm Lowry's *Under the Volcano*

Randy Jasmine
  Dixie State College of Utah

Even though the opening pages of Malcolm Lowry's masterpiece, *Under the Volcano*, reveal that the action of the novel commences in November 1939, some 7 months after the official end of the conflict, the

specter of the Spanish Civil War looms over the action and the characters, waiting for a chance to explode in the form of guilt, regret, and recrimination. Unlike Hemingway and Orwell, who both chose to participate in and record the conflict in Spain directly, Lowry provides an indirect and somewhat obscured perspective of the war: a perspective similar to that of most non-Spanish observers. In this paper, I examine the complexities that exist in Lowry's relationship to and engagement with the brutal events in Spain and how these factors spill over into the novel. Lowry's flawed protagonist in *Under the Volcano*, the consul, experiences his own form of wartime trauma as he drunkenly stumbles toward a violent death, murdered by fascists, not in Spain, but in Mexico. Lowry's highly subjective narration opens the door to an analysis that can be equally subjective. I suggest that through this lens, an active and meaningful link between a traumatic historical event and an individual manifestation of human pathology is strongly developed. In essence, *Under the Volcano* effectively demonstrates Keats's concept of "negative capability" in literature and in literature's connection to political thought.

LETTERS—LITERATURE

It Was Worth It: Overcoming the "Consumer Identity" in the Freshmen Composition Classroom

Kate Kimball
Utah Valley University/Salt Lake Community College

Mark Edmundson, in "On the Uses of a Liberal Education," argues that one of the problems that instructors of English face is the "consumer" identities of their students. Students are paying for a college education, and they should get what they think they deserve, or so it seems. Because of the perceived subjective nature of writing within the English classroom, this becomes even more problematic for the instructor. At times, it may seem easier to hand out "A's" than to reinforce correct practices with writing and deal with a plethora of student complaints. To overcome this, the classroom becomes inherently important in serving the students as a space in which to experiment with various forms of writing. Using the classroom as a studio, as Rhonda C. Gregpo and Nancy S. Thompson have theorized, allows students to gain an even greater knowledge of the rhetorical aspect of writing. As they argue, "As Porter and colleagues note, composition researchers and pedagogues who focus on the classroom as a site for change do so 'without

adequately theorizing the institution . . . [thus making] institutions seem monolithic and beyond the individual's power for change.'" This paper investigates ways in which teachers of composition can use the classroom as a "studio" and how that practice can improve the learning of students.

LETTERS—LITERATURE

Good People Make Good Friends

Douglas Christensen
University of Utah

Although this paper argues primarily from the perspective of the writing teacher, my thesis applies broadly to any college instructor who responds to student writing. Most of the concentration in the 'response to student writing' literature focuses on the effectiveness of corrections and rhetorical responses to students, and the most current work seems especially interested in the success of response to students who speak English as a second language. Dana Ferris suggests that "because the teacher is the teacher, any feedback is likely to influence what students do subsequently—and experts disagree as to whether this influence is ultimately helpful or harmful." Ferris's insight here reminds us that the voice of the student is always under the duress of colonization and erasure by the imperialism of the voice of the teacher and therefore the agency of the other is always exposed to the risk of the violence of appropriation, but this can be ameliorated when the self responds to the other responsibly. This paper brings three ideas together to offer the teacher a strong alternative interpretation of his or her purpose for response to student writing.

The overarching idea comes from the apophatic theology of Emanuel Levinas. Levinas's general argument holds that the self or the ego always has responsibility for the other—that the self is quite literally defined by this 'proximity' to the other. His use of this trope 'responsibility' manifests itself as response to the other. I use this trope, this call to respond, to outline the theoretical motive of the teacher's response to student writing. But the name I give to this response is that of critical friendship. Critical Friendship draws upon the ancient intellectual tradition of friendship but clarifies its role as a critical one. One of the primary sponsors of critical friendship, Sue Swaffield refers to it as "the point of balance along a continuum from 'total friend' to 'total

critic.'" Taken together, the reason to respond and the name for this response help me build my case that we can achieve something in our communication with students that we are often recommending they try to achieve in their writing, namely ethos. Most people agree that ethos identifies an appeal in speaking and writing that establishes the credibility of the speaker/writer by ensuring a particular kind of character. Others have dusted off another ancient dimension of ethos that points us to ethos as a dwelling place (see *The Ethos of Rhetoric* by Michael J. Hyde). I argue that we have a Levinasian responsibility to respond ethically to our students' writing, and we can frame that response in terms of critical friendship and in so doing achieve an understanding of ethos that complements our efforts as responders and their efforts as writers.

PHYSICAL SCIENCES

What We Don't Teach in General Chemistry

Chin-yah Yeh
  Utah Valley University

The topics include: What indicates a chemical change? What characterizes a chemical bond? Is chemical energy stored in chemical bonds? Is nuclear chemistry, chemistry? What is matter, as defined in chemistry? Are there indeed 3 states of matter? Is Avogadro's number a universal constant? We will cover some other awful things we don't let students know in general chemistry.

PHYSICAL SCIENCES

Rough Surface Reflections

Gregory R. Hart, Sam Keller, and Steve Turley
  Brigham Young University

Optical surfaces in extreme ultraviolet have rough features on the order of a wavelength. To characterize the effect of this on reflections, our group has developed a method for computing reflection from rough surfaces with arbitrarily high accuracy. We developed a realistic model for sputtered and evaporated thin-film surfaces that is controlled by two parameters, rms surface height and a cut-off spatial frequency. The model is based on atomic force microscopy (AFM) measurements,

which indicate that the roughness is generally of low spatial frequency. The model is based on transforming a surface with normal random noise in its height into frequency space; applying a low pass Gaussian filter of a variable width. After transforming the filtered surface back to real space, we have a surface that nicely mimics measured AFM data. We compare our computations of reflections from this surface with the commonly used Debye-Waller and Nevot-Croce correction factors.

PHYSICAL SCIENCES

Learning in a Group: A Better Model for Both Students and Instructors

Maomao Cai
 Weber State University

Most traditional learning models rely on students' individual studying activities. In these models, the efficiency of learning varies among different students and, thus, is limited. In this paper, we propose a systematic group learning model. This model has advantages to overcome the shortages of the individual study model and can improve the efficiency of students' studies. Furthermore, in this model, students can learn from the group as well as from the instructors, thus the teaching performance can also be improved. We use statistical techniques to evaluate the improvement of teaching performance for the proposed group model.

PHYSICAL SCIENCES

Non-specular Reflectance in the Extreme Ultraviolet

Quintin Nethercott
 Brigham Young University

The surface roughness is critical in extreme ultraviolet (EUV) optics because something very smooth relative to visible wavelengths can be very rough in the EUV. Our current method of characterizing roughness using atomic force microscopy (AFM) reaches a limit in its measurements around three nanometers. To evaluate non-specular

measurements' effectiveness as a tool for characterizing surface roughness, we have measured non-specular reflectance off of samples of varying roughness and compared those with predictions from previous calculations and AFM measurements. As a result, we have improved our ability to characterize surface roughness in the EUV by utilizing non-specular reflectance to compliment and improve the AFM measurements, thus advancing our knowledge of the optical properties of materials in the EUV.

PHYSICAL SCIENCES

The Anomalous Growth of Yttria Films in Controlled Atmospheres

James Schwab and David Allred
  Brigham Young University

Several years ago our group discovered that reactively sputtered Y2O3 films swell—up to a factor of 8 in thickness—when exposed in air to ultraviolet photons (7.2 eV) from an excimer lamp. It has been established that the effect is observed even when most of the oxygen in the atmosphere is removed by diluting the ambient with either nitrogen or argon in a glove box. I am studying the effect of removing all of the oxygen from the ambient and will need a VUV window. I have tested sapphire and MgF_2 windows. The UV photons go through the MgF_2 but not the sapphire. A MgF_2 window on a vacuum flange will allow the light into a vacuum system where the oxygen can be removed.

PHYSICAL SCIENCES

Comparison of SABER Measurement

Jordan C. Rozum and Gene A. Ware
  Utah State University

The SABER instrument aboard the TIMED satellite went online in 2002 and has been providing radiometric data concerning the MLTI region of the atmosphere. Researchers at the Utah State University NASA Spacegrant Consortium have been tasked with validating measurements taken by SABER of the volume emission rates of hydroxyl airglow in the infrared. To this end, we compare SABER measurements

of hydroxyl airglow altitude distributions to measurements taken by photometers aboard rockets launched in the years between 1961 and 1986. We select SABER scans that occur near these launch sites at the same time of year and at similar solar zenith angles, then plot the corresponding altitude profiles alongside renormalized profiles measured by rocket-borne photometers. Important considerations for comparison are the mean thickness of emission layers, the mean altitude of their centers, and relative numbers of bifurcated airglow emission layers, which manifest as altitude profiles with multiple peak emission rates.

PHYSICAL SCIENCES

Categorizing Profile Exceptions in the SABER OH Data

Malea Moody, Gene A. Ware, and Doran Baker
Utah State University

SABER is a satellite-borne multichannel radiometer used to globally measure infrared emissions from the mesospheric-thermospheric regions of the Earth's upper atmosphere. The spacecraft was launched in December 2001 and became fully operational in February 2002. Ten different channels measure emissions from eight atmospheric gas species. The channels used at the Utah State University NASA Space Grant Consortium are the OH 2.0 and the OH 1.6. After receiving data from the satellite, the data are processed to be validated. Through the data validation process, it was found that there are profiles that are anomalous in comparison to the profile expected. These are referred to as profile exceptions. This paper discusses what profile exceptions are, what to expect in a normal profile, what defines a profile exception, and the categories that the different profiles fall under.

PHYSICAL SCIENCES

Chaos in Driven Quantum Oscillators

Ryan T. Sayer
Brigham Young University

Lyapunov exponents characterize the tendency of two initially close phase-space trajectories to diverge over time. A positive-valued

Lyapunov exponent indicates the presence of chaos in a system. I will briefly discuss the significance and determination of Lyapunov exponents. I will apply Lyapunov methods to a driven quantum Morse oscillator system and evaluate Lyapunov exponents for driving force strengths and durations ranging two orders of magnitude.

PHYSICAL SCIENCES

Relativistic Tsiolkovsky Equation and Space Travel with Relativistic Velocities

Jeremy Redd and Alexander Panin
Utah Valley University

The possibility of using antimatter in future space propulsion systems is seriously discussed in scientific literature. The annihilation of matter and antimatter is not only the energy source of maximum density, $9x10^{16}$ J/kg, provided that antimatter fuel is available on board or can be collected along the journey, but also potentially allows one to reach the ultimate exhaust speed—the speed of light, c. Using the relativistic rocket equation, we discuss the feasibility of achieving relativistic velocities with an annihilation-powered photon engine, as well as the advantages and disadvantages of interstellar travel with relativistic and ultra-relativistic velocities.

PHYSICAL SCIENCES

Modeling Motion of a Small Black Hole via a Planet or a Star

Victoria Turova and Alexander M. Panin
Utah Valley University

In some scenarios of Big Bang, the fluctuations of density in the early universe result in the formation of various-sized primordial black holes. The black holes of mass range 10^{11}–10^{24} kg are suitable candidates for a dark matter or at least for a part of it. Such black holes could from time to time pass through the Solar System, the Sun, or even the Earth. What would a trajectory of a small black hole passing via Sun or via Earth look like? What other effects would take place? We model com-

putationally a motion of a small black hole moving with various initial velocities between 10 km/s and 1000 km/s via a planet-like and a star-like body of various density distributions. The results of this modeling are presented.

PHYSICAL SCIENCES

Modeling Nuclear Explosions

Jeremy Redd and Alexander Panin
Utah Valley University

As a result of the Nuclear Test Ban Treaty, no nuclear explosion tests have been performed by the U.S. since 1992. This appreciably limits valuable experimental data needed for improvement of existing weapons and development of new ones, as well as for use of nuclear devices in non-military applications, such as making underground oil reservoirs or compressed air energy storages. This, in turn, increases the value of numerical modeling of nuclear explosions and of their effects on the environment. We develop numerical codes simulating fission chain reactions in a supercritical U and Pu core and the dynamics of the subsequent expansion of generated hot plasma to better understand the impact of such explosions on their surroundings. The results of our simulations of both aboveground and underground explosions of various energy yields are presented.

POSTER SESSION

Intrasource Separation

Brendan Coutu
Brigham Young University

With the advent of electrospray ionization, mass spectral analysis of the cellular lipidome has become possible. Even though our understanding of the lipidome lags far behind that of the proteome and genome, lipidomics is becoming a valuable tool in understanding the mechanisms and cellular effects of diseases. By adopting a method of separating different lipid species based on their pKa's, we have been able to more fully identify complete lipidomes of different species. This separation technique known as intrasource separation involves adding a low con-

centration of LiOH to a portion of a lipid sample. Our work with lipidomics is a step toward analyzing the complete interactome of a sample. The differences in lipids and their concentrations gives us an idea of the mechanisms and cellular affects of these diseases and will help us determine new treatments that can be used in treating and reversing the effects of them.

POSTER SESSION

OH Cube Sat

Braydon Williams
Utah State University

Our cube sat will scan the atmosphere at 80 to 90 km up for infrared light put off by OH. These observations will further our understanding of the effects of geomagnetic storms in the earth's atmosphere.

POSTER SESSION

Wind Monitoring System

Ty Weaver and Ryan
Rocky Mountain NASA Space Grant

We have been putting together a monitoring system for recording weather conditions. The data collected by this system is being used for calibration of wind turbines.

POSTER SESSION

Ultra Mafic Origins of the Beaver Dam and Virgin Mountains

Sean Julander
Southern Utah University

The origins of the ultramafic rock in the Welcome Springs Area of the Beaver Dam Mountains and Elbow Canyon in the Virgin Mountains are important to understanding Precambrian tectonics. Samples of ul-

tramafic rocks from the Beaver Dam and Virgin Mountains were characterized mineralogically and chemically. Mafic rocks from the Welcome Springs Area of the Beaver Dam Mountains are composed of amphibolite with minor amounts of plageoclase, pyroxene, quartz, calcite, and muscivite. Mafic rocks from Elbow Canyon contain similar mineral assemblages. An ultramafic rock from Elbow Canyon includes olivene, clinopyroxene, orhtopyroxene, amphibole, and minor amounts of spinel. X-ray fluorescence spectrography (XRF) techniques were used to determine major and trace element concentration of rock samples. Geochemical and mineralogical data were used to determine the ultimate origin of these rocks, i.e., part of mantle, oceanic crust, or an intrusion. This information is used to determine the tectonic setting at Precambrian.

SOCIAL SCIENCE

Theoretical Foundations of Federal Land Exchanges: A Public Choice Perspective

Giancarlo Panagia
Westminster College

This article evaluates federal land swap practices. In land exchanges, the federal government swaps public lands with private parties in the interest of consolidating federal ownership and better managing the public domain. Special attention is given to the Bureau of Land Management (BLM) and the United States Forest Service (USFS) that carry out the bulk of these exchanges. The issue that is the main component of this research is the (under)-valuation of public lands that are transferred out of the public domain, notwithstanding both federal agencies keep on revising their practices.

Tto better understand why federal land management agencies, such as the BLM and the USFS, engage in land exchanges where the government loses value, we must examine political and public choice theories. This article employs a political and economic analysis of federal land exchanges with private parties. While the political theory is used to describe a macro-analysis of institutions and organizations and how they relate to land swaps, the public choice theory analysis is meant to provide an analysis of individuals' behavior and their impact on the market and its transactions. These two theories provide the foundation of the analysis concerning the behavior of federal agencies and their

individual employees. These combined analyses will allow a full analysis of the spectrum of both agencies' behavior, as organizations at one pole and as aggregates of individuals at the other. This dual analysis will explain how issues of organizational mismanagement (principal/agent problems) and capture, combined with improper, unethical, and, in a few instances, criminal behavior by individual officials, could be the cause of the loss of equal value in land swaps.

SOCIAL SCIENCE

Changing Sex Ratios among Utah Mormons

Rick Phillips, Ryan C. Cragun, and Barry A Kosmin
University of North Florida, University of Tampa, and Trinity College

Christian denominations in the United States have a surplus of women. Surveys show that women significantly outnumber men within Catholicism and every major Protestant tradition. This paper examines the distribution of male and female members of The Church of Jesus Christ of Latter-day Saints (the LDS, or Mormon, Church) in the United States. Like other major Christian denominations in the U.S., the LDS church has a surplus of women; however, because of their unique geographical distribution, the trends in sex ratios are different for Mormons than for other large denominations. We find that the feminization of Mormonism is occurring faster in Utah and the western United States than it is in other parts of the country. We examine various data sets from Utah and the Intermountain West to explain this pattern.

SOCIAL SCIENCE

Predicting Voting Intentions: An Extension of the Theory of Planned Behavior

Douglas K. Peterson and Sarah Mather
Westminster College

The theory of planned behavior will be tested by examining student questionnaire data on their past voting behavior and voting intentions for the 2012 congressional and presidential elections. It is expected that the empirical results of the study will provide general support for

the theory of planned behavior through the application of multiple regression analysis. An additional factor, personal norms, and two antecedent conditions, impersonal causality orientation and past behavior, are added to the model in an attempt to improve the model's ability to predict intentions and behavior. It is hypothesized that the results will indicate that the theory of planned behavior is more effective in predicting intentions to vote when personal norms are added to existing factors in the model (attitudes, social norms, and perceived behavioral control). Results will also indicate that the antecedent conditions impersonal orientation and past behavior will affect attitudes and perceived behavioral control in terms of arriving at the polling place.

SOCIAL SCIENCE

Full Equality for Lesbian, Gay, Bisexual, and Transgender People: The Influence of Younger People

Linda Stay
Dixie State College

Public opinion toward equality for lesbian, gay, bisexual, and transgender (LGBT) people has improved significantly in the last ten years. The largest gains in support are coming from people aged 18–35. Two elements are paramount in that shift: 1) Belief that homosexuality is innate; and 2) having a close personal relationship with someone that is LGBT. The current research explored the factors influencing younger people's attitude shift toward LGBT people and support for their rights. Of particular interest is involvement on social networks, specifically Facebook, on influencing tolerance and acceptance. The current research used an online survey to measure influence levels toward acceptance and equality. The variable of interest is measured using multiple-choice answers to determine the degree and source of influence. Results indicate a significant increase of support for LGBT equality regardless of age, gender, or religious affiliation.

SOCIAL SCIENCE

Rising to the Middle: The Rise, and Possible Fall, of the American "Us"

Kip Joseph Kay
   University of Utah

For decades, politicians, scholars, and journalists have argued that the American middle-class is in decline—the message being so prevalent that it is now accepted as common knowledge. What is not as widely understood, however, is who exactly constitute America's middle-class. In surveys, Americans with annual incomes between $8,000 and $800,000 identify themselves as belonging to the group; moreover, economists and sociologists seem to offer no less insight into the question, insisting only that the middle-class must lay somewhere between "rich" and "poor." Rising to the Middle offers conceptualizations of "middle-classness" as they have existed during the last 400 years. Economic data, news reports, and demographic information are used to track the socio-economic progress of the people of the United States from colonization to present day and presents a possible narrative for American economic identity.

SOCIAL SCIENCE

The Effects of Music Timing on Task Time Perception and Performance

Wendy Uribe and Megan Belmont
   Dixie State College

Music is found in almost every culture and is clearly important but not fully understood. Music has been, and is still being, used as a form of therapy. Many studies show that music can effect vigilance, decision making, and task completion and alter the effects of time. To determine whether music could actually help with task completion, attention, decision making, and perception of time, this study will use a driving game to observe whether people perceive time as moving faster when listening to high-tempo music and completing a task and also whether their actual time will improve with faster tempo music. The hypothesis is that people will perceive their completion time as being shorter while

listening to fast-tempo techno, but that their actual shortest time completion will be while listening to slow-tempo techno.

SOCIAL SCIENCE

Utah Space Pioneer David C. Evans and "The First Internet"

Doran Baker
Utah State University

In December 1969, entrepreneur Dr. David C. Evans at the University of Utah hooked up his computer by long distance to the Stanford Research Institute (SRI) as part of the First Internet, called ARPANET. This innovative computer data network was funded by the Advanced Research Projects Agency (ARPA). As part of the frantic national response to the Soviet launching of Sputnik in October 1957, President Dwight D. Eisenhower in 1958 had proposed ARPA as a federal agency within the Department of Defense. This paper covers Dr. Evans's contributions during this historic time.

SOCIAL SCIENCE

Is the Intermountain West Becoming Segregated?

Dwight Israelsen and Ryan Israelsen
Utah State University and Indiana University

With much current national discourse centered on the politics of division, it is of interest to know whether the Intermountain West is becoming segregated and to identify the factors leading to increases or reductions in segregation rates. The current study examines the pattern and determinants of racial/ethnic segregation by Intermountain county and state, based on census tract data for Non-Hispanic Whites, Hispanics, Blacks, Asians (Asians/Pacific Islanders), American Indians (Indians and Alaskan Natives), and All Other. The two most commonly used measures of segregation, the isolation index and the dissimilarity index, were calculated for each racial/ethnic group in each Intermountain county for 1990, 2000, and 2010. Based on these individual indices, racial/ethnic-population-weighted segregation indices were calculated for each Intermountain county, state, and the region for these years.

Racial concentration ratios were also calculated for each county, state, and the region for these years. Changes in the segregation indices and RCRs between 1990 and 2010 and between the sub-periods are used to determine whether the Intermountain West is becoming segregated.

SOCIAL SCIENCE

A Political Economy Analysis of Twitter and Sina Microblog

Yanqin Liu
  University of Utah

As a popular microblogging service, Twitter has received a great deal of the public's attention because of its convenience and timeliness, the amount of information it makes available, and the lively manner in which it is presented. Sina Microblog is a Twitter-like service that dominates China's microblog market. From the perspective of political economy, this paper compares Twitter and Sina to show the similar and different ways in which these services profit from their users, exert social influence on others, and contribute to freedom of expression and social justice. This analysis applies Mosco's point, commodification, and concludes that these two services benefit from their users by transforming use values into exchange values. On both sites, the immaterial labor of microbloggers and their followers can be the primary sources of products. However, Twitter has a higher degree of commodification, while Sina localizes its functions to meet Chinese users' needs.

SOCIAL SCIENCE

Technology in the Classroom

Brett Bartruff, Gina Brewer, Athian Deng, Mary Byra, and Kerry Kennedy
  Weber State University

This study addresses the impact personal technology has on face-to-face (lecture) college classes. Literature reviews show that studies are beginning to expand on how students are using this new technology and whether it hinders or enriches education. A survey was self-created by the class to ask questions about personal devices students use in the

classroom setting, how often they use their device for non-educational uses during a lecture, and if the use of this technology is distracting during a lecture. The respondents were undergraduate students at Weber State University. This 23-question survey was sent through the university e-mail system. Demographics include race/ethnicity, gender, age, whether students are traditional or non-traditional students, GPA, and standing in school. We expect to find relationships between use of technology in the classroom and level of distraction.

SOCIAL SCIENCE

Caregiver Loops: A Correlational Study of Attachment, Empathy, and Perceptions of Infant Cues

Justin K. Nuckles
  Dixie State College

Interactions and relationships formed in the first three years play a crucial role in determining subsequent development. This study is a correlational study of three interacting characteristics that influence interactions with young children. Participants will be invited to participate in a self-report survey, consisting of three measures, the Experiences in Close Relationships–Revised (ECR-R), the Interpersonal Reactivity Index (IRI), and a custom measure derived from infant cues identified by NCAST Programs at the University of Washington. Results will be analyzed using SPSS statistical analysis software for correlation (r) significance. It is hypothesized that individuals who are more accurate in identifying infant cues will also score higher in empathy and display a more secure attachment style.

SOCIAL SCIENCE

Panel Exploring the Experience of U.S. Combat Veterans: A Focus on PTSD

This is a panel of presentations by four separate authors.

Inequality and War: A Battle on the Home Front

Daniel Poole
   University of Utah

While the emergence of armed conflict is often directly influenced by inequality and social disparity, in this paper I focus on the implications of war regarding disparity and social inequality experienced by military veterans in the United States. After extensive searches of academic literature, I have found very few studies that explore armed conflict through a demographic lens. Researchers who have explored this topic agree that not enough attention has been paid to demographic implications of war. By exploring the demographic construct of the U.S. military while examining rates of PTSD and other trends, this paper seeks to shed light on emerging collective experiences of American service men and women returning from war.

Conflict in Fulfilling the Social Contract between Society and Combat Veterans

Roger Johnston
   University of Utah

This descriptive study explores whether there is a conflict of values occurring in society from the combat veteran's perspective. Based on the narratives of soldiers exposed to combat, there appear to be patterns indicating that a conflict of values does exist. The rational construct of values systematically held in a societal context unravels within the context of war and its returning combat veterans. Through interviews and participant observation, this preliminary study seeks to understand the experience of American service men and women who have returned from war. Two different veteran cohorts will be sampled for this study. These cohorts will include veterans of the Vietnam War and of the current Global War on Terror. Comparisons between these groups will help to add additional insight into the experience of cognitive disso-

nance associated with reintegration into civilian society and whether or not this is a structural issue commonly experienced by veterans.

A Perspective on Heroism, in the Context of War, From a Warrior

Dan Powers
   University of Utah

Answering the question of needing *a special kind of hero in our present age* is difficult. Anyone can be viewed as a 'hero' from some person's perspective. The paradox of modern war is that those who serve are lauded as heroes, but the truth is far more complicated. The modern idea of a hero is an impossible standard. Society too often writes off those who defend us once they are found to be real people and not perfect. Heroes are created to provide examples to aspire to. In contrast, ancient heroes are presented with fatally bad qualities that are the catalyst for their ultimate demise. The Greeks leave us the best surviving example of 'pursuit of the ideal body' in the Olympics. Heroism, by its very nature, is elusive. Those who seek it are arrogant, and those who avoid it have reasons that we are not privy to know.

A Soldier's Experience: Reintegration into the Machine

Jade 'Doc' McDermaid
   Salt Lake Community College

This paper explores reintegration from combat to civilian society from a personal perspective. As a combat veteran recently returning from tours of active duty in Iraq, this paper explores my struggles and conflicts that are taking place with my assimilation back into American civilian society. Areas of focus include an examination of what the Department of Defense is doing to help combat troops returning from deployment, the constant struggle with interpersonal relationships experienced by combat veterans, and the resources available to assist veterans returning from service.